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FOREWORD

This interim report describes the analytical and experimental work conducted to identify the onset of reactive stream separation and develop techniques to predict its occurrence. The activity was performed by Aerojet Liquid Rocket Company on Contract NAS 9-14186, under the direction of Merlyn Lausten, NASA/JSC Project Manager. Aerojet personnel included L. B. Bassham, Program Manager, D. L. Kors, Project Manager and B. R. Lawver, Project Engineer.

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I INTRODUCTION AND SUMMARY

A. Introduction

The objective of this program was to develop an understanding of the mechanisms controlling hypergolic propellant reactive stream separation (RSS) and with that understanding develop design criteria which will allow the design of high performing injectors free from both steady state RSS and cyclic propellant stream separation ("pops"). This objective was accomplished through test and analysis of single element injectors using principally N_2O_4/MMH propellants. Injectors and test conditions were representative of the Space Shuttle Orbit Maneuvering Engine and Space Tug applications. The program consisted of four primary tasks:

Task I - Review of Existing Models and Experimental Data

The Task I objectives were to:

- Critique all existing models relating to RSS.
- Review and summarize all associated RSS data.
- Formulate updated RSS model based on existing data.

Task II - Detailed Program Plan Preparation

The Task II objective was the preparation of a detailed program plan, i.e., the formulation of a detailed method of approach to be taken for model testing and verification in subsequent tasks.

Task III - Definition of Governing Mechanisms

The Task III objectives were to define the mechanisms governing RSS, establish limits for RSS and "pops", and to define appropriate models and included:

- Design, fabrication and testing of two single element unlike doublet injectors.

- Incorporation of high speed photographic techniques for visual propellant stream characterization.

- Correlation of propellant stream behavior (RSS) with various independent test variables (data analysis and evaluation).

Task IV - Verification of Governing Mechanisms

The Task IV objectives were to:

- Establish operating limits for RSS (and ("pops") for other injector types.

- Verify mechanisms governing RSS and the appropriate physical models resulting from the Task III work.

The Task IV effort included the design, fabrication and testing of triplet and self-atomizing platelet injectors. The term "self-atomizing" as used here means that a single propellant provides the atomization, either by self impingement or by impingement with a surface.

B. Summary

1. Task I - Model and Data Review

Results of the Task I model review effort indicated that neither of the two existing blowapart models (JPL model and

ALRC model) adequately described RSS nor correlated the existing RSS experimental data. New correlations were developed using hydrazine data that showed that the chamber pressure, orifice diameter, and propellant temperature exhibit controlling influences over blowapart. Four regimes of reactive stream impingement were defined: (1) mixing, (2) popping (cyclic blowapart), (3) low pressure separation ($P_c \leq P_{sat_{ox}}$), and (4) high pressure separation (P_c > 300 psia).

New model concepts of reactive impingement were formulated on the basis of known hypergolic reaction mechanisms to account for all four modes. Hypergolic reaction was hypothesized to occur either as, high enthalpy gas phase oxidation reactions, low enthalpy surface reactions, fuel monopropellant gas phase reaction, or liquid phase reaction. However, subsequently true liquid phase reactions were deemed unlikely due to the reported immisibility of Amine fuels and N_2O_4 and the observed lack of liquid phase mixing produced by impinging streams of water and dyed water. Also, the fuel monopropellant gas phase reactions hypothesis was subsequently shown to be difficult to correlate with the observed RSS regimes. The mixing regime was postulated to be controlled by gas phase reaction in that mixing occurs under conditions of low gas phase concentrations. Popping was postulated as a transition from the low enthalpy surface reaction to the high enthalpy gas-phase reactions as observed for droplet ignition. The low pressure mode of RSS was found to be due to flash vaporization of N_2O_4. Originally, the high pressure mode of RSS was postulated to be caused by recirculation gas heating of the fuel stream to its decomposition temperature ahead of impingement. However, this concept was subsequently revised on the basis of Task III and IV results.

2. Task II - Program Plan

The Task II Program Plan consisted of preparing a detailed work plan which included all aspects of program planning,

i.e., program approach, hardware requirements, test plan and analytical requirements. This work was documented in Report 14186-DRL-1.

3. Task III - Definition of Governing Mechanisms

During the Task III testing the high pressure (300-1000 psia, 2-7 x 10^6 N/m^2) mode of RSS was explored to define controlling mechanisms and verify the Task I model concepts. Also regions of RSS for the unlike doublet injector element were mapped. High speed (800 FR/sec) color movies were used to observe and define operating modes. Tests were run with two unlike doublet elements of differing impingement lengths to verify the high pressure RSS model. Both the experimental results and Task I analytical calculations showed recirculation gas heating to be inadequate to cause RSS by monopropellant decomposition. Therefore, it was concluded that other mechanisms are operative.

The high speed color movies showed that RSS occurs gradually as the chamber pressure is increased rather than in a sudden step change; at least with MMH and A-50 fuels. It was also observed that the severity of RSS increases with increasing chamber pressure, fuel velocity, and fuel temperature.

Exploratory impingement point temperature measurements were made using a 0.020 inch (.051 cm) diameter thermocouple probe to try to develop a better understanding of the reaction mechanisms. The probe results showed that the impingement point temperature increased with chamber pressure and injection velocity. The data showed an apparent temperature discontinuity at a chamber pressure of about 400 psia, (2.8 x 10^6 N/m^2) corresponding to the MMH saturation temperature. The temperature jump was interpreted as a change in reaction mechanism from low enthalpy surface reactions to high enthalpy gas phase reactions.

It was concluded that surface reactions play an important role in RSS and that both the photographic and the temperature probing technique should be improved during the Task IV testing to develop a clearer understanding of RSS.

4. Task IV - Verification of Governing Mechanisms

The Task IV test results showed that the RSS is best correlated with a gas phase/surface reaction model. Orifice hydraulics were found to significantly influence RSS. For example, unlike doublet injectors using rounded or contoured orifice inlets were found to suppress RSS at low injection velocities as compared to sharp edged inlet orifices. Injector design correlation equations which define the onset of RSS were developed for a wide range of injector elements using both EDM and platelet orifices.

It was concluded that both gas phase and surface reactions control RSS. The rate of the surface reaction appears to be mixing limited rather than kinetically limited, as the propellants can react as fast as they can be put together, i.e., the reaction time is much shorter than the mean contact time. Also, based on the Task IV analysis it appears that increasing the interfacial surface area before impingement increases the surface reaction and hence RSS. For example, the data show a Reynolds number influence on RSS and also show that unlike impingement of self-atomized or pre-atomized streams promotes RSS.

Several correlation equations were evaluated during the program to relate RSS to injector design and operating parameters. The best correlation to date relates RSS to chamber pressure and a dimensionless propellant reactivity parameter, R. where R is defined as the product of fuel Reynolds number and the

square root of the product of the fuel and oxidizer vapor pressures divided by the chamber pressure:

$$R = Re \times \sqrt{P_{VF} \times P_{VO}}/P_c$$

(Complete nomenclature is contained in Appendix A)

Using this parameter the onset of RSS can be characterized by a minimum chamber pressure for RSS by the power form equation

$$P_{c_{RSS}} = a R^b$$

where a and b are functions of injector design and, perhaps, propellant combination, as will be discussed in Section III. The adequacy of the correlation can best be judged by referring to the data plots and model curves as shown in Appendix B.

Other correlation equations are currently being evaluated in order to more completely characterize the variables which influence RSS.

II RESULTS AND CONCLUSIONS

A. Results

The most significant result of this program was the identification of the gas phase/surface reaction mechanism which controls RSS. Injector design criteria which defined a critical chamber pressure for those operating conditions above which RSS occurs were developed from data correlations based on this mechanism. As defined here a surface reaction is produced by the diffusion of the surrounding vapor (N_2O_4) to the liquid (fuel) surface causing an on-going reaction which results in heat input and vaporization of the liquid to sustain the reaction

Significant effort was devoted to the development of meaningful RSS correlations during the Task IV effort. The final correlations are based on data from a parallel RSS study (Ref. 25), an OMS subscale study (Ref. 26) and the Zung data (Ref. 27) as well as the data from this study.

A wide variety of RSS correlating parameters were investigated and are tabulated in Appendix C, with the best correlation being provided by plotting the chamber pressure versus a dimensionless propellant reactivity parameter, R, as shown in Figure 1. Additional data showing the model correlation are contained in Appendix B. The reactivity parameter is the product of the fuel orifice Reynolds number and the square root of the propellant vapor pressure products divided by the chamber pressure. As described in Section VA, it is believed that the interfacial surface area at the impingement point controls RSS and that propellant stream properties are an important consideration. For example, increasing fuel stream Reynolds number apparently increases the amount of surface reaction. Curves defining RSS operating regimes are summarized in Figure 2 for a wide variety of injector elements and for MMH, A-50, and N_2H_4 fuels.

The degree of gas phase reaction depends on the amount of propellant vapor available, which depends on the propellant temperatures. Hence, increasing the propellant temperature increases the amount of gas phase reaction. The chamber pressure influences the gas-phase reaction through the propellant vapor concentrations which increase with pressure.

It was found that the rounded inlet long L/D orifices used on this study and the Rocketdyne study (Ref. 25) suppresses RSS at low values of the Reactivity parameter, as compared to sharp edged short L/D orifices. The chamber pressure at which RSS occurs is seen to be strongly dependent on the specific element type suggesting a strong influence of hydraulics on the inter-facial surface

area at impingement. In general the pre-atomized type of element exhibits the earliest onset of RSS, viz, the like-on-like doublet and platelet elements.

It was found that both the MH and A-50 rounded inlet data can be correlated with the same curve. The influence of the N_2H_4 fuel is not conclusive since data with the rounded inlet injector is not available.

B. Conclusions

The most significant conclusions are:

1. RSS occurs in two modes depending on chamber pressure: (1) surface reaction mode - when fuel saturation temperature is less than impingement zone temperature and (2) gas phase reaction mode - when fuel saturation temperature is greater than impingement zone temperature.

2. The onset of RSS is controlled primarily by the operating chamber pressure and secondarily by the propellant reactivity and the amount of interfacial surface area at impingement.

3. RSS does not occur discontinuously but rather gradually with severity increasing with chamber pressure.

4. The propellant reactivity is controlled by the propellant temperature/vapor pressure relationship.

5. Increasing propellant temperature increases reactivity and promotes RSS.

6. The amount of interfacial surface area at impingement is controlled by the injector hydraulics (i.e., orifice configuration and Reynolds number).

II Results and Conclusions (cont.)

7. Unlike impingement of self-atomized or pre-atomized propellant streams promote RSS through increased interfacial surface area.

8. Contouring the orifice inlets of unlike impinging streams can suppress RSS by reducing interfacial surface area.

9. The mechanisms controlling pops were not verified.

10. RSS can be related to chamber pressure and a propellant reactivity parameter, R. The minimum chamber pressure for RSS can be specified by a power-form expression relating Pc to R with coefficients and exponents a function of the injector design.

11. Further refinement of the RSS correlation equations is desirable in order to more adequately account for propellant stream influences on RSS.

III APPLICATION OF RESULTS

Injector design criteria were derived from the RSS data correlations by fitting curves of the form:

$$P_{c_{RSS}} = a\, R^{b}$$

where:

P_{sep}	=	chamber pressure above which RSS will occur
a	=	experimentally determined constant
b	=	experimentally determined constant
R	=	$Re_f \sqrt{\dfrac{P_{vox} \quad P_{vf}}{P_c}}$

Re_f = Fuel stream Reynolds Number

P_{ox} = N_2O_4 vapor pressure at the injection temperature

P_f = fuel vapor pressure at the injection temperature

The experimentally determined constants are summarized in Table I. The chamber pressure above which severe RSS occurs is found by selecting the applicable values of a and b from Table I and calculating R from the propellant temperatures, orifice geometry, and injection velocity. For example, given a like-on-like injector using MMH and the following design and operation conditions:

d_f = 0.025 in. (.064 cm)

V_f = 65 ft/sec (19.8 in/sec)

P_c = 125 psia (8.6×10^5 N/m^2)

T_f = 70°F (294°K)

T_{ox} = 70°F (294°K)

The fuel Reynolds number is:

$$Re_f = \rho_f V_f d_f / \mu_f$$

where,

ρ_f = 54.5 lb/ft^3 @ 70°F (872.5 Kgm/m^3 at 294°K)

μ_f = 5.5×10^{-4} lb/ft-sec @ 70°F (8.19×10^{-4} N-sec/m at 294°K)

therefore,

Re_f = 13,418

the vapor pressures are:

$$P_{vox} = 15 \text{ @ } 70°F \ (1.03 \times 10^5 \ N/m^2 \text{ at } 294°K)$$

$$P_{vf} = 0.75 \text{ @ } 70°F \ (5.2 \times 10^3 \ N/m^2 \text{ at } 294°K)$$

therefore,

$$P_{vox} \ P_{vf}/P_c = 0.0268$$

and $R = 13{,}418 \times 0.0268 = 360$

From Table I,

$$a = 125$$
$$b = -0.05$$

therefore,

$$P_{sep} = 125 \ (360)^{-0.05} = 93 \text{ psia } (6.41 \ N/m^2)$$

RSS would be expected to occur at chamber pressures above this.

IV RECOMMENDATIONS

The following recommendations are made;

1. The injector design criteria developed here should be incorporated into the JANNAF DER performance program to indicate when an injector design is operating in an RSS mode.

2. New correlation data should be generated for unlike doublet elements using orifice geometries representative of flight injectors.

IV Recommendations (cont.)

3. The influence of fuel type should be verified using N_2H_4, A-50, and UDMH.

4. Large orifice diameter (.060 inch, .152 cm) unlike doublets should be tested to determine mechanisms controlling pops.

5. Experimental correlations between RSS severity and performance loss should be generated using the experimental techniques developed here and on the OMS Subscale Program (Ref. 26).

6. Additional refinement of the existing RSS correlations should be attempted in order to more completely characterize propellant stream/spray fan influences on RSS.

V TECHNICAL DISCUSSION

A. RSS Model

During Task III it was concluded that RSS was a surface reaction controlled phenomena and that it could be correlated with the Weber number. A Weber number model was constructed to explain the observed pressure and velocity influence on RSS. The Weber number is the ratio of aerodynamic surface forces to the surface tension forces acting on a liquid droplet or stream as shown in Figure 3. It is used to characterize droplet breakup due to aerodynamic force. A critical Weber number exists beyond which droplets are shed or stripped from the surface. It was postulated that RSS would occur beyond the critical Weber number due to increased interfacial surface area and hence increased reactivity as a result of jet shedding ahead of impingement.

Preliminary data plots showed good correlation with the Weber number. However, Task IV testing showed the need to include a fuel temperature effect over and above the surface tension

influence. This was accomplished by modeling the fuel and oxidizer vapor phase concentrations just ahead of impact as shown in Figure 4. It was assumed that the vapor phase is in equilibrium with the liquid phase such that the vapor phase concentration is described by the vapor pressure as determined by the bulk propellant temperature. With this model increasing fuel temperature decreases the vapor phase mixture ratio such that the vapor phase becomes more reactive. The vapor phase mixture ratio is described by the equation;

$$MR_{vp} = P_{ox}\ Mw_{ox}\ T_f / P_f\ MW_f\ T_{ox}$$

where:

P_{ox}	=	oxidizer vapor pressure @ T_{ox}, psia
P_f	=	fuel vapor pressure @ T_f, psia
MW_{ox}	=	oxidizer molecular wt.
MW_f	=	fuel molecular wt.
T_{ox}	=	oxidizer injection temperature, °R
T_f	=	fuel injection temperature, °R

As shown in Figure 5, the Weber number and propellant vapor pressure parameters correlate the unlike doublet RSS data well. However, correlations with other injector data were not as good and it was necessary to re-examine the model to derive new correlation parameters.

The dependence of RSS on the Weber number is due to the strong chamber pressure and injection velocity influence. It was found during the Task IV cold flow experiments that the onset of self-atomization and jet shedding depends on the Reynolds number as well as the Weber number. For example, it was found that jet shedding begins at a Weber number of 3 for turbulent jets produced

by sharp edged orifices as compared to 12 for jets produced by contoured inlet orifices. This led to the realization that the orifice geometry and the Reynolds number influence the interfacial surface area.

The chamber pressure and fuel temperature dependence suggests a gas phase reaction mechanism as described by the classical reaction rate equation;

$$\frac{d[C]}{dt} = -k \quad C_1^{m} \quad C_2^{n}$$

where:

C_1, C_2	=	concentration of reactants, (moles/cc)
k	=	rate constant
m,n	=	concentration exponent

For the classical gas phase reaction the reactant concentrations are related to the partial pressure through the ideal gas law;

$$C_1 = n_1/V = p_1/RT \quad \text{moles/cc}$$

where:

n_1	=	no. of moles of species 1
V	=	reaction volume, cc
p_1	=	partial pressure of species 1, atm
R	=	universal gas constant, atm/°K-mole/cc
T	=	gas temperature, °K

The concentration is related to the total pressure through the mole fraction;

$$C_1 = x_1 \quad P/RT$$

where:

x_1 = mole fraction of species 1

Therefore, increasing chamber pressure increases the reaction rate and heat release rate in the gas phase through increased reactant concentrations.

The fuel temperature also influences the gas phase reactions through its effect on reactant concentrations. The partial pressure of the reactants in the impingement zone are controlled primarily by the propellant vapor pressures. If it can be assumed that the propellant vapor is in equilibrium with the liquid phase then the vapor phase concentrations become direct functions of the propellant temperatures.

The functional relationship between the reaction rate and the concentrations depend upon the specific reaction mechanism. For example, the hydrazine/nitrogen dioxide gas phase reaction was found to exhibit two reaction steps depending on the gas temperature (Ref. 13). In the lower temperature regimes ($T < 900°K$) the step I reaction stoichiometry is;

$$N_2H_4 + NO_2 \longrightarrow 1/2\ N_2H_4 + H_2O + NO + 1/2\ N_2$$

with the rate being controlled by the following hydrogen abstraction reaction;

$$N_2H_4 + NO_2 \longrightarrow N_2H_3 + HONO$$

The complete reaction mechanism is given in Ref. 13. The rate equation is;

$$d\,[N_2H_4]/dt = -k_1\ [N_2H_4]\ [NO_2]$$

where:

$[N_2H_4]$ = Hydrazine concentration

$[NO_2]$ = nitrogen dioxide concentration

$k_1 = 10^{15.83}\ e^{-26,700/RT}$

In the higher temperature regime (T > 1000°K) the step II reaction stoichiometry is;

$$1/2\ N_2H_4 + NO \longrightarrow H_2O + N_2$$

with the rate controlled by hydrazine decomposition;

$$N_2H_4 \xrightarrow{M} NH_2 + NH_2$$

The step II reaction rate is;

$$d\,[N_2H_4]/dt = -\,k_2\ [N_2H_4]$$

where;

$$k_2 = 10^{10.17}\ e^{-39,600/RT}$$

The Step I reaction is more likely to occur under the relatively low temperature conditions of reactive stream impingement. The functional relationship between the propellant concentration and the reaction rate for the Step I reaction is:

$$d\,[N_2H_4]/dt = k_1\ [p_{N_2H_4}/RT]\ [p_{NO_2}/RT]$$

$$= -k_1/(RT)^2\ [p_{N_2H_4}]\ [p_{NO_2}]$$

Therefore, it is expected that the propellant temperature influence should be correlated with a parameter containing the product of the

fuel and oxidizer partial pressure (i.e., vapor pressure).

The partial pressures were normalized by the chamber pressure for correlation purposes. It was found that the best correlation is obtained by plotting the chamber pressure versus the product of the fuel Reynolds number and the square root of the normalized partial pressure product.

B. Task I - Model and Data Review

The results of the literature review and model critique were the: (1) description of the problem, (2) tabulation and evaluation of results of all prior RSS work, (3) critical evaluation of two RSS models, (4) development of RSS data correlation for hydrazine fuel, and (5) development of new RSS model concepts. These results are discussed in detail.

1. Problem Description

Popping and RSS are important design considerations because they have been found to adversely affect performance and stability. RSS has been observed to significantly reduce the performance of the following types of impinging injectors:

- Unlike Doublet
- Triplet
- Like Doublet

Experimental test results from the various OMS Engine Technology programs have provided quantitative data of the effect of RSS on performance caused by increasing the fuel temperature from ambient to a level simulating operation with a fuel regeneratively-cooled chamber (~ 200°F, 367°K). In many cases, the

injector performance decreased almost linearly with increasing fuel temperature. For example, as shown in Figure 6 the energy release efficiency decreased from 2 to 5% as the fuel temperature was increased from 50 to 240°F with two ALRC subscale OMS unlike doublet injectors. Similar results were also obtained with the full scale OMS unlike doublet injector.

Performance reductions due to RSS have been found to be influenced by:

- Propellant Temperature
- Element Size
- Element Spacing
- Chamber Length

The effect of RSS was lessened with increasing chamber length and decreasing orifice size as shown in Figure 6. RSS was noted with both N_2O_4/A-50 and N_2O_4/MMH propellants.

Random high amplitude short duration (less than a millisecond) pressure and accelerometer disturbances were observed with the N_2O_4/Amine fueled Apollo Spacecraft engines during their development phase and more recently on some OMS development engines. These disturbances, called pops, are undesirable because they may trigger damaging combustion instability. In all of the Apollo engines the pops were eliminated or reduced to acceptable levels through trial and error testing since there were no design criteria by which logical element or pattern changes could be made. The pops were generally attributed to random accumulation and monopropellant explosion of fuel pockets or zones caused by such things as poor element or pattern design, orifice flow instabilities (hydraulic flip), plugged oxidizer orifices, or fuel leakage through weld cracks.

Although these causes are certainly possible recent investigations demonstrate that the observed pops are related to combustion phenomena associated with unlike hypergolic propellant stream impingement. For instance, it has been shown (Ref. 1-5) that small local explosions of fuel and oxidizer, rather than monopropellant fuel explosions, are the source of pop triggers. The pops and/or pop triggers can upset engine stability by driving the feed system dynamics and/or chamber acoustics.

This program was undertaken because the mechanisms controlling pops and RSS were not thoroughly understood such that meaningful injector design criteria could be developed. The first task was to critically review the prior related work to develop a rational starting point. The results of this task are discussed below.

2. Literature Review

A summary of the literature review is contained in Appendix D. The key finding of each investigator is summarized under the comments heading. A summary of the range of parameters covered in these studies is shown in Table II.

Past investigations had (1) identified four operating regimes for hypergolic stream impingement, (2) demonstrated techniques of identifying and measuring RSS and pops, (3) identified many of the design and operating parameters influencing RSS and pops, (4) provided a multitude of RSS and pop data, and (5) postulated two theoretical models for the prediction of one or more of the reactive impingement regimes.

Experimental studies had identified four operating regimes for reactive stream impingement as illustrated in Figure 7. The occurrence of these regimes was found to be dependent on many

engine operating and design parameters. The conditions found to be conducive to the occurrence of each operating regime are listed in Figure 7, although a quantitative description of these operating regimes was found to be lacking.

The following sensing techniques had been used to identify the various impingement regimes in past investigations:

- Photographic
- Performance Measurement
- Pressure Measurement
- Accelerometers
- Mass Spectrometer
- Thermocouples

Photographic techniques provide a qualitative measure of the reactive stream flow characteristics and were used in the first reported evidence of stream separation (Ref. 6). High speed movies were also instrumental in the identification of cyclic blowapart of single doublet elements (Refs. 2, 3, 5 and 7). The performance measurement technique with conventional chambers provided a psuedo-quantitative measurement of stream separation by comparing the performance of a system while varying the parameter which influences stream separation (Ref. 8). For example, the decrease in performance with increasing fuel temperature resulted presumably from increasing reactive stream separation. Performance measurements with a baffle chamber provided more conclusive quantitative measurement and was capable of identifying the mixed, separated, and penetrated flow regimes (Ref. 9). The P_c and accelerometer measurements have been used to identify the "popping" regime (Refs. 1, 3, 5, and 9). Finally, the mass spectrometer and thermocouple measurement techniques were used to measure the mixture ratio distribution downstream of the reactive stream impingement providing a quantitative measurement of the reactive stream mixing process (Ref. 11).

It was concluded that photographic techniques could best be used to define RSS mechanisms because the flow field can be magnified for close examination.

3. Model Review and Critique

The JPL model and ALRC model were the only models reported in the literature for predicting the occurrence of RSS and pops. Each of these models were reviewed and checked for accuracy using the accumulated RSS data.

a. JPL Model

The first model is that developed by Kushida and Houseman (Ref. 12) of the JPL. It postulates two regimes of RSS, (1) a low pressure separation due to liquid phase reactions, and (2) a high pressure separation due to gas phase reactions. The model defines the regimes of mix and separation in terms of the chamber pressure, propellant temperature, and impingement contact time (D/V) as shown in Figure 8.

The low-pressure-separation condition was postulated to occur when the liquid phase reactions heat the propellants to the bubble point. This condition exists when:

$$T_{P_i} \geq T_B$$

where:

T_{P_i} = propellant temperature at the impingement point

T_B = propellant boiling temperature

Although Kushida does not develop this portion of the model in detail in the literature, it can be done as follows. T_{P_i} is determined by the liquid phase heat release rate and the contact time within the impingement zone.

$$T_{P_i} = T_{P_o} + \Delta T_P$$

where:

T_{P_o} = propellant injection temperature

ΔT_P = temperature rise due to liquid phase reactions

ΔT_P = $\dot{Q}$ tr M_R/M_H C_p

$\dot{Q}$ = liquid phase heat release, K cal/sec-mole oxidizer

M_R = mass of propellant reacted, moles

M_H = mass of propellant heated, moles

C_p = specific heat of propellant, cal/mole-°K

tr = contact time, sec.

using:

C_p = 23 cal/mole-°K for hydrazine

$\dot{Q}$ = 83×10^3 kcal/sec-mole of oxidizer*

ΔT_P = 3.6×10^6 °K/sec x tr x M_R/M_H

The average contact time is:

tr = D/V

where:

D = jet diameter, feet

V = jet velocity, ft/sec

*Kushida's reported value of 83 kcal/sec-mole of oxidizer is in error.

To calculate ΔT_p requires that the ratio M_R/M_H be assumed. Although Kushida does not report the value used it was calculated to be about 0.27 as follows: Figure 8 shows separation is predicted to occur below pressures of about 38 psia (2.6×10^5 N/m^2) for a contact time of 40 μ sec and 40°F (278°K) propellants. Using this contact time and the N_2O_4 saturation temperature at 38 psia (2.6×10^5 N/m^2), the assumed ratio of M_R/M_H is about 0.27.

The second mode of stream separation is postulated to occur at high pressure due to gas phase reactions at the propellant stream interface. The interface is modeled as a stable gas film separating the liquid streams. The rate of fuel and oxidizer transport into the film is presumed to be limited by vaporization. The reaction film thickness is determined by a momentum balance on the reaction volume. Using a hydrazine/N_2O_4 reaction mechanism and rate reported by Sawyer and Glassman (Ref. 13) Kushida is able to develop a relationship between the contact time (D/V) and the pressure through the gas density.

Separation is postulated to occur if:

$$D/V > 35\ (100/P)^{-1.5}$$

where:

P = chamber pressure, psia

The weakness of this model is that it assumes the existence of a stable gas film with laminar flow at the contact point. Recent cold flow and reactive impingement experiments (Refs. 3, 4, and 5) show the impingement process to be highly unstable and cyclic in nature.

The RSS/pop data summarized in Appendix D were plotted on the pressure/contact time coordinates (Figure 9)

to check the Kushida model. It is evident that the model does not adequately correlate the mix and separation regimes.

b. ALRC Model

The second model, developed by Lawver (Ref. 1) of ALRC, describes regimes of mix, pop, and separation for reactive stream impingement as well as describing inter-element spacing requirements for preventing coupling of single-element pops with adjacent element sprays. Reactive stream impingement is postulated to be controlled by liquid-phase reaction kinetics and mixing. The onset of stream separation is postulated to occur when the stream residence time exceeds the ignition delay time:

$$\tau_{RES} \geq \tau_{ign}$$

where:

$$\tau_{RES} = D/V$$

and:

$$\tau_{ign} = Y \quad e^{E/RT}$$

Y	=	reaction rate constant
E	=	activation energy
R	=	Universal gas constant
T	=	Propellant temperature

The pops are postulated to be due to the ignition of well-mixed fuel and oxidizer within the ligament formation zone. Pops occur when:

$$\tau_{lig} \quad \tau_{ign}$$

where:

$$\tau_{ig} = (200/V) \quad (D/V)$$

For a complete derivation see Reference 1.

The regimes of mix, pop, and separation are defined by plotting (1/T) versus (D/V) as illustrated in Figure 10.

Using this model of reactive stream impingement, a stream separation parameter, I, was defined such that:

$$I = (\tau_{ign})_{SEP}/(\tau_{ign})$$

where:

$(\tau_{ign})_{SEP}$ = ignition delay at separation limit

τ_{ign} = ignition delay as determined by fuel temperature

A large set of Apollo engine pop data, in the 100-150 psia pressure range, were correlated with this parameter (Ref. 1) to define regimes of engine popping. The data correlations showed that most engines operate within the regime of element popping, therefore, it became necessary to prevent inter-element coupling to eliminate the engine pops. On the basis of high speed movies (Ref. 2) which showed the element pops to be highly localized explosions it was theorized that the pops behave as spherical blastwaves in which the pressure decays rapidly with distance. With this theory it was possible to develop the following element spacing parameter.

$$D = R/S$$

where:

$R = 49.2\ (D_f/P_c^{1/3})$ in.

D_f = fuel orifice diameter

P_c = chamber pressure

S = element spacing, in.

See Ref. 1 for a complete development. Coupling occurs when:

$$D \geq 1.2$$

Application of this spacing criteria to the Apollo SPS IOS injector (Ref. 1) eliminated the popping.

The RSS data tabulated in Appendix A were plotted on the (1/T) versus (D/V) coordinates to check the Lawver theory. The results showed poor correlation especially at higher pressures. The atmospheric pressure data are shown in Figure 11. It is evident that this model does not adequately define the mix, pop, and separate regimes.

The model's failure to adequately correlate the various regime does not invalidate its ability to accurately predict pop coupling. The pop blastwave coupling model merely states that given a regime of element popping, coupling will or will not occur given certain conditions of chamber pressure, element size and spacing. The successful application on the Apollo IOS and the ALRC OME engine studies is ample verification.

Since neither the Kushida or Lawver models adequately correlate the operating regimes it was desirable to develop a new model of reactive stream impingement.

V Technical Discussion (cont.)

4. Development of Data Correlations

The data generated by the following investigators were tabulated for computerized data analysis:

- Lee and Houseman (Ref. 5)
- Zung and White (Ref. 27)
- Nurick and Cordill (Ref. 4)

A computer program was written to summarize the data and to calculate and plot correlation parameters. The computer listing and data summaries are included in Appendix D. Of all the correlations plotted the factors providing the best correlation are:

- Chamber Pressure
- Orifice Diameter
- Propellant Temperature

These factors were found to exhibit the controlling influence over the occurrence of the mix, pop, and separation regimes.

The data were used to construct correlation plots to define the first order controlling parameters. This was done by plotting the data versus several parameters including:

- $1/T_f$ vs $(D/V)_f$
- P_c vs. D_f
- P/D vs. T_f
- P/D vs. $(D/V)_f$

- P/D^2 vs. T
- P_c vs. $1/V_f$
- P_c vs. T

The limits of occurrence of RSS and popping were observed to be primarily dependent on the chamber pressure and orifice diameter. The orifice diameter was found to exhibit an overwhelming influence on the pop limit as shown in Figures 12 and 13. These plots also indicate the existence of two distinct modes of RSS for hydrazine; a high-pressure mode and a low-pressure mode as previously reported by Zung (Ref. 3). The low pressure mode is associated with N_2O_4 boiling which prevents stream penetration and mixing. The second mode of RSS occurs at pressures above 300 psia (2.1 x 10^6 N/m^2). Modeling of this RSS mode is discussed in the subsequent section.

In summary the data correlations showed four distinct modes of reactive stream impingement for hydrazine fuel;

- Mixing
- Popping
- Low Pressure RSS ($P_c < P_{sat\ ox}$)
- High Pressure RSS ($P_c >$ 300 psia, (2.1 x 10^6 N/m^2)

5. New Model Concepts

A new model of reactive stream impingement was formulated through the examination of the new RSS data correlations and re-examination of the physical and chemical processes involved. The new model presumes four regimes of reactive impingement as identified by the data correlations: (1) mixing or penetration, (2) popping (cyclic blowapart), (3) low pressure separation, and (4) high pressure separation. The existence of these regimes is believed

to be a consequence of the complex reaction mechanisms of the N_2O_4/Amine propellants. Hypergolic reaction has been observed to occur in four basic modes:

- High enthalpy gas-phase oxidation reaction
- Low enthalpy surface reactions
- Monopropellant decomposition
- Liquid phase reactions

However, it is believed that liquid phase reactions are not a factor in RSS since true liquid-phase reactions have been observed only with dilute mixtures of N_2O_4 and N_2H_4 (Ref. 14). They are not likely to occur under reactive stream impingement conditions due to the immiscibility of the propellants and the apparent low degree of liquid/liquid mixing observed with cold flow liquid stream impingement. Also, it has been subsequently determined, based on the Task III work, that the postulated monopropellant decomposition model of RSS is incorrect (See Section V.C.2).

During the proposal phase, high speed color movies were taken of cold flow stream impingement using streams of water and dyed water in an effort to more fully understand the impingement process. It was found that impingement is cyclic in nature due to the normal streak breakup processes. The formation of surface waves is evident in the film sequence. The stream breakup process is controlled by the stream hydraulic and interfacial forces.

Examination of the movie sequence showed the existence of distinct globs of water and dyed water indicating a lack of liquid-phase mixing. Therefore, nonreactive impingement of miscible fluids appears to be dominated by interfacial forces. Likewise, reactive stream impingement of immiscible fluids is also expected to be

dominated by interfacial forces. Extensive liquid-phase mixing is not expected. This conclusion was also reached by Breen et. al., (Ref. 17), on the basis of reactive tests. Also reaction kinetic data derived from N_2O_4/N_2H_4 stream impingement data (Ref. 18) were found to agree well with the gas kinetic data of Sawyer and Glassman (Ref. 13). This observation along with that of Weiss, et al., (Ref. 19) showing N_2O_4/N_2H_4 to be immiscible led Breen to the conclusion that the reaction between liquid surfaces may be controlled by vapor phase kinetics.

Evidence in support of this theory is provided by the results of the hypergolic impingement experiments of Rodriguez (Ref. 20) meant to measure liquid phase reaction rate. The measured heat release rates reported by Rodriguez would suggest that MMH is more reactive than N_2H_4 which seemingly conflicts with other impingement test results which had indicated N_2H_4 to be more reactive. However, his results are reasonable if in fact a gas-phase reaction is measured. A rather clear correlation is provided by comparing the vapor pressure to the measured heat release rate as shown in Table III. These data show that the measured heat release rate increases with the fuel vapor pressure and show the MMH to be more reactive than the N_2H_4.

Hypergolic surface reactions were first described by Lawver during a study of N_2H_4 droplet combustion (Ref. 21). Droplet ignition was observed to occur through a surface reaction which produces a white milky substance on the droplet surface which has since (Ref. 21) been identified as ammonium nitrate. Ignition proceeds by surface reactions which heat the liquid fuel to the ignition point as shown in Figure 14. At the ignition point the reaction changes from the surface to that of a droplet diffusion flame.

In a later study Zung (Ref. 22) characterized N_2O_4/N_2H_4 ignition. Photographs taken during this study clearly show

surface reaction phenomenon. Ignition was found to be a transition from low enthalpy surface reaction to high enthalpy vapor phase reaction as illustrated in Figure 14. Zung found the ignition point to depend on the N_2O_4 concentration and the N_2H_4 temperature, as shown in Figure 15.

At N_2H_4 temperatures below 107°F, ignition (i.e., transition from surface reaction to diffusion flame) is controlled by diffusion of N_2O_4 vapor to the liquid N_2H_4 surface. At temperatures higher than this, ignition is controlled by vapor phase kinetics. Above 187°F ignition is influenced by N_2H_4 decomposition kinetics.

It was concluded that RSS and popping are dominated by surface and gas phase reactions and that liquid phase reactions are not important. Controlling reaction mechanisms were postulated for each of the four impingement regimes as illustrated in Figure 16. The pop was postulated to be a consequence of the transition from a low enthalpy surface reaction mode to a high enthalpy gas-phase reaction mode with attendant ignition of explosive intermediates formed during the pre-ignition phase. The transition is a consequence of self-heating by the surface reactions. The heat-up time and the amount of heating both depend on the orifice size. Small orifices produce smaller ligaments which can heat to the ignition point before appreciable amounts of intermediates are formed. They also restrict the contact time (i.e., heat-up time). Larger jets produce correspondingly larger ligaments which allows sufficient self-heating and intermediate accumulation to produce pops. The self-heating by surface reaction is controlled by the volume to surface ratio and is therefore a function of the orifice diameter.

Stream mixing was postulated to occur when the orifice diameter is sufficiently small to prevent pops or when the pressure is sufficiently high to suppress transition from surface reaction to vapor-phase reaction until the ligaments are shed into droplets.

Low-pressure RSS occurs when the N_2O_4 temperature exceeds its saturation temperatures. The resultant two-phase stream enhances surface and/or gas phase reactions which prevent interdispersion of propellant droplets.

High-pressure RSS was postulated to be a consequence of monopropellant decomposition of the fuel vapor due to recirculation gas heating of the fuel stream ahead of impact. The resultant decomposition would produce gas-phase reactions upon contact with the oxidizer stream and the separation would be controlled by the fuel vapor pressure. However,subsequent analyses and data from the Task III effort indicates the recirculation gas heating to be of negligible consequence over the range of injection parameters surveyed.

POSTULATED POP MECHANISMS

Previous studies had identified the following pop characteristics:

- Cyclic nature
- Explosions originate close to impingement point
- Explosions emit high velocity blastwaves
- Explosions have been classified as to their strength
- Frequency of occurrence and strength depends on diameter, D/V, and fuel properties

Nurick and Cordill (Ref. 4) suggested the possibility that the explosions may be due to either ignition by impact of explosive intermediates or ignition of mixed propellants. The possibility of ignition of shock-sensitive intermediates by impact was shown to be unlikely since the calculated impact forces for typical stream velocities are orders of magnitude lower than that required for detonation. For instance the maximum impact energy for a 0.040 in. diameter

jet at 50 ft/sec velocity is 43 x 10^{-8} ft-lb. A minimum of 4-ft-lb is required (Ref. 16) to detonate the intermediates. Also it was observed that the popping frequency and strength decrease with increasing velocity which is the inverse of that expected for an impact ignition mechanism.

It was postulated during the proposal phase that the explosions may also be triggered by compression of the gas bubbles formed as a result of the surface reactions. Adiabatic compression of the gas bubbles by liquid stream impact could produce sufficiently high temperatures to trigger the explosive intermediates. This process would be expected to be highly random in nature. This mechanism was not experimentally investigated because it is believed that the explosions are most likely due to ignition by hypergolic self-heating through interfacial surface reactions as described above. This mechanism was not investigated.

POSTULATED HIGH PRESSURE RSS MECHANISM

The Task I data correlations showed that high pressure RSS occurs above 300 psia for N_2O_4/N_2H_4. It was also noted that the N_2H_4 saturation temperature (450°F) at this pressure coincides with the N_2H_4 vapor decomposition temperature (Ref. 15). This observation suggested a monopropellant decomposition mechanism for high-pressure RSS. It was postulated that RSS could occur as illustrated in Figure 17 by recirculation gas heating of a significant portion of the N_2H_4 to its saturation temperature prior to impact. When the saturation temperature exceeds 450°F (506°K) then monopropellant decomposition occurs causing RSS, as illustrated in Figure 17. At 300 (2.1 x 10^6 N/m^2) psia this would result in monopropellant decomposition of the N_2H_4 thus preventing stream mixing. Extending the theory to other fuels would suggest that separation with MMH and A-50 would occur at higher chamber pressure due to their higher vapor pressures as shown in Table IV.

It was decided to analytically verify this theory during the contract Task I effort. The results of the modeling presented in the following section indicates inadequate heating of the free stream to heat a significant portion of the fuel stream to the saturation temperature. The analytical results were experimentally verified in Task III by testing with elements having different free stream lengths (i.e., different impingement distance).

The recirculation gas heating of the free-stream was modeled as illustrated in Figure 18. Combustion recirculation gas heats the surface film of fuel to the boiling point in the free-stream ahead of impact. The resultant surface film monopropellant decomposition prevents inter-propellant stream mixing.

The fuel stream liquid temperature and fuel vapor temperature were calculated using the heat and mass transfer equations developed by Priem in NASA-TR67 for droplet vaporization. A cross-section of the fuel jet illustrated in Figure 18 shows the vaporization mechanism. Also shown are the typical temperature profiles for fuel vaporization with and without monopropellant decomposition of the fuel vapor. The influence of the decomposition is to increase the heat flux to the droplet by steepening of the temperature gradient. The equations describing the heat and mass transfer are also shown in Figure 18. These equations were computer coded for a finite difference calculation. The classic Ranz-Marshall correlation was used for fuel vaporization without decomposition and a predicted Nusselt number which accounts for decomposition was used for the case of monopropellant decomposition. A computer listing is included in Appendix D.

The computer results indicate that for a hydrazine free-jet length of 4 L/D's injected at 50 ft/sec (15.2 m/sec) the liquid temperature rise would be on the order of only 10°F (5.6%) for jets from .027 to .060 inches (.069 to .152 cm) diameter at 300 psia (2.1×10^6 N/m^2) chamber pressure. Less than .1 percent of the liquid

mass would be expected to vaporize prior to impingement. These calculations indicate that insufficient pre-impingement heating occurs to heat the fuel stream to the saturation temperature. Thus it was concluded that free-stream heating by recirculation gas does not control high pressure RSS. Subsequent experiments support this conclusion. However, recirculation heating may increase the free jet boundary layer temperature and result in more droplet shedding due to increased Weber number due to lower jet boundary surface tension and add to gas generation.

The conclusions drawn from the Task I results were:

(1) Previous investigations had identified four operating regimes of reactive stream impingement; (1) Mixing - impingement results in uniform spray field mixture ratio distribution, (2) Separation - impingement results in non-uniform spray field mixture ratio distribution with fuel and oxidizer striations, (3) Pentration - impingement results in non-uniform spray field mixture ratio distribution with fuel and oxidizer "shoot through", and (4) Popping - Impingement results in random or cyclic explosion of spray field producing blowapart and blastwaves.

(2) Two regimes of RSS exist, a high pressure mode (P_x > 300 psia (2.1×10^6 N/m^2) for hydrazine) due to reactive stream blowapart and a low pressure mode ($P_c < P_{sat_{ox}}$) due to oxidizer boiling.

(3) The operating and design factors exhibiting the greatest influence on RSS and popping with hydrazine fuel are: (1) chamber pressure, (2) orifice diameter, and (3) propellant temperature.

(4) Neither the Kushida (JPL) or the Lawver RSS models (ALRC) adequately correlate RSS and popping and a new RSS model is required.

(5) RSS appeared to be related to four possible mechanisms of hypergolic reaction; (1) high enthalpy gas-phase reaction, (2) low enthalpy surface reactions, (3) monopropellant decomposition, and (4) liquid phase reactions. High pressure RSS was concluded to be a result of monopropellant reaction, however, Task III and IV testing show this not to be case. It was also concluded that liquid phase reactions are not important due to the predominance of surface reactions and lack of liquid phase mixing.

C. Task III - Definition of Governing Mechanisms

During the Task III effort two unlike doublet injector elements were designed, fabricated, and tested in a photographic test chamber with four GN_2 cooled quartz windows. The injection elements were identical except for impingement length which was varied to test the monopropellant decomposition RSS model formulated in Task I.

High speed movies of reactive stream impingement were taken over the pressure range of 100-1000 psia (6.89 - 68.9 N/m^2). It was observed that; (1) photographic clarity decreased with increasing chamber pressure, (2) RSS was not sensitive to impingement length for the range tested (0.160 - 0.060 inches .406 - .152 cm), (3) RSS occurs gradually as pressure is increased from 100-1000 psia (6.89 - 68.9 N/m^2) and that RSS severity increases with chamber pressure, fuel temperature, and injection velocity, and (4) RSS severity depends on fuel composition - MMH separates at a lower chamber pressure and at lower propellant temperature than does A-50.

A temperature probe technique was used to measure impingement point reaction temperature rise. A discontinuity in the impingement point temperature rise as chamber pressure is increased was observed. These results are discussed in detail.

1. Task III Test Objectives and Conditions

The two unlike doublet injector elements were tested over the range of parameters listed in Table V in an effort to determine the mechanisms controlling RSS. The injectors, test chamber, and test setup are described in detail in Section V,E.

The Task III test objectives and results are included in Table V. A detailed test condition log was maintained and is included in Appendix B. The test data were stored in a computer data file for easy manipulation and correlation. A listing of the reduced data is included in Appendix E.

The objectives of the first series of tests (#101-106) were to verify proper test stand operation and to check the photographic equipment. The tests showed that the backlighting intensity was too bright and that the test stand functioned as required. Examination of the movie pictures showed the unlike doublet to be separated at all of the conditions tested. Separation is defined as the appearance of unmixed oxidizer in the spray field evidenced by clouds of dark brown NO_2. Although density gradients between the cold window purge gas and the hot combustion gas obscured detail in the impingement zone at the higher pressures, the spray field operating mode was readily discernible.

The backlight was modified prior to the next test series to improve photography. A sheet of polorized filter paper and a sheet of ground glass were placed between the Fresnel lense and the test chamber to reduce the backlighting intensity and to eliminate parallel light from the quartz lamp.

The next series of tests (#107-111) were run at lower pressures to determine the pressure limit of RSS. The onset of RSS was found to occur between 100 and 150 psia (6.89 and 10.3 x 10^5 N/m^2) with ambient temperature MMH. The recirculation gas model

developed in Task I had predicted separation at about 400 psia (2.75×10^6 N/m^2) with MMH. RSS was found to gradually worsen with increasing pressure. The density gradients produced by the GN_2 purge were still visible but their intensity was found to decrease with pressure. Good, clear pictures were obtained at the lower pressures (100-200 psi, 6.89-13.78 x 10^5 N/m^2).

The next set of tests (#112-123) were run with A-50 to determine the influence of fuel vapor pressure on RSS. The hot gas recirculation model had predicted that A-50 would separate at 500 psia (3.44×10^6 N/m^2) as compared to 400 psia (2.75×10^6 N/m^2) for MMH. The data showed ambient temperature A-50 to separate at about 200 psia (13.78×10^5 N/m^2) as compared to about 150 psia (10.3×10^5 N/m^2) for the MMH. The increase in separation severity with pressure is readily apparent in Figure 19 which shows a series of single movie frames from successive tests at increasing chamber pressures. Test No. 117 was run at a lower injection velocity to determine its influence on RSS. The movie film shows notably less separation at the lower velocity (88 ft/sec, 26.8 m/sec) than at the nominal velocity (125 ft/sec, 38.1 m/sec.

The next series of tests (No. 124-132) were run with the short impingement length doublet to determine the influence of recirculation gas heating on RSS. The Task I model had indicated that RSS should depend on impingement length. The movie data do not show any discernible difference in separation characteristics between the long impingement (0.160 in., .406 cm)and the short impingement (0.060 in., .152 cm) doublet elements.

Test Numbers 134-138 were run with heated fuel over the pressure range of 100-250 psia (6.89 - 17.2 x 105 N/m^2). The movies show a pronounced worsening of separation with increased fuel temperature. This influence is demonstrated by the movie frames shown in Figure 20. Also shown in Figure 20, is the thermocouple used to probe the impingement point in the subsequent set of tests.

The onset of separation was found to occur at 100 psia (6.89×10^5 N/m^2) with 200°F (367°K) MMH.

The final Task III test set (No. 139-152) was run with ambient temperature propellants and the thermocouple probe mount-d as shown in Figure 20. Initially, a 0.010 in. (.0254 cm) dia. thermocouple was used, however, it lacked sufficient mechanical strength to remain in a fixed position. It was discarded for a more rigid 0.020 in. (.0508 cm) dia. thermocouple. The movies indicate some disruption of the impingement by the thermocouple particularly at the lower velocity conditions, however, the temperature data are reasonably consistent and orderly. The temperature probing technique appeared to offer significant quantitative data on impingement point heating and therefore was improved and used during the Task IV testing. These temperature data were used to correlate propellant stream temperature rise, ΔT, to fuel Weber number and is thought to contribute to RSS.

2. Task III Interpretation of Test Results

The impingement process was observed to be cyclic in nature in both the mixed and separated modes. Although detailed frequency measurements were not made, the characteristic frequencies appeared to correspond to the frequencies observed in cold flow suggesting that the cyclic nature is characteristic of the ligament shedding process. Energetic cyclic blowapart (i.e., popping) was not observed on any of the test. The Task I data correlations would indicate that none should have occurred with the small orifice diameter used.

The RSS data for both MMH and A-50 fuels were plotted on the pressure versus temperature scales as shown in Figure 2 for comparison with the Task I data correlations previously displayed in Figures 12 and 13. It is noted that the A-50 separates at a higher pressure than the MMH and that the pressure at which MMH

separates decreases with increasing fuel temperature. The N_2H_4 data of Zung (Ref. 27) did not reflect an influence of inlet temperature on high pressure RSS.

Listed in Table IV are the predicted and measured RSS pressure limits for ambient temperature MMH and A-50. Also included is Zung's N_2H_4 data for reference. The pressure limits were predicted on the basis of the recirculation gas heating model developed in Task I. The model states that separation should occur at the pressure corresponding to the fuel vapor pressure at 450°F, the vapor phase decomposition temperature. It is seen that the pressure levels do not agree and that the trend in fuel type is correct for MMH and A-50 but not for N_2H_4. In view of this and the fact that the analytical calculations had indicated insufficient heating, the hot gas recirculation model does not appear valid.

The experimentally measured (Ref. 20) heat release rates and the onset of RSS as shown on Table VI would seem to indicate a correlation between RSS and propellant reactivities, as measured by the heat release rates. This dependence on propellant reactivity was experimentally observed by noting that the impingement point temperature was found to depend on the chamber pressure and the propellant velocity. These influences appeared to be accounted for by adding the propellant stream dynamic head to the chamber pressure as shown in Figure 22. Also included in Figure 22 are the saturation temperature lines for N_2O_4 and MMH. There appears to be two modes of RSS as evidenced by a step change in temperature. The temperature discontinuity is believed to be indicative of a change in reaction mechanism as suggested by the popping regime mechanism described in Section IV.B.3. It is believed that low enthalpy surface reactions heat the propellants to their saturation temperatures and that when the fuel saturation temperature is exceeded, the reaction switches to a high enthalpy gas phase reaction.

It was also thought that the onset of visual separation might occur when the impingement point temperature exceeds the N_2O_4 saturation temperature. However, as indicated in Figure 22 this was not found to be true as there are mixed conditions above the N_2O_4 saturation temperature. It was concluded that the onset of RSS could not be correlated with impingement point temperature rise alone.

The low enthalpy surface controlled reaction was expected to be primarily a function of the propellant interfacial surface area at the point of impact which is expected to be related to propellant stream turbulence level or Reynolds number. A dependence of impingement point ΔT on fuel Reynolds number (R_{ef}) up to the point of transition from low to high enthalpy reaction was found. Beyond the transition there was no dependence of impingement point ΔT_i on R_e. Examination of the movie film brought the realization that a free jet may also experience self-atomization prior to impingement, thus influencing the effective surface area at impact. The self-atomization of a free stream is characterized by the ratio of aerodynamic to surface tension forces as described by the Weber number. The impingement point temperature rise was plotted versus the fuel and the oxidizer Weber number as shown in Figure 23. There appeared to be some dependence of ΔT_i on Weber number. It is noted that the temperature transition occurs beyond the critical Weber No. which signifies the onset of self atomization and increased surface area. It was noted that the occurrence of visual RSS was also correlated by the critical Weber number.

The following conclusions were drawn from the Task III results:

(1) The GN_2 window purge produces visible gas density gradients which obscure the spray field at higher pressures. Consequently Task IV tests were conducted both with helium purge gas and without purge gas which verified this conclusion.

(2) The proposed monopropellant decomposition model of RSS is incorrect.

(3) RSS depends on surface reactions.

(4) RSS occurs in two modes depending on chamber pressure: (1) low enthalpy reaction (fuel saturation temperature less than impingement point temperature), (2) high enthalpy reaction (fuel saturation temperature greater than the impingement point temperature).

(5) The Weber number is a useful RSS correlation parameter and Task IV testing should explore the surface controlled reaction mechanism further.

D. Task IV - Verification of Governing Mechanisms

The work conducted during this task resulted in; (1) the improvement of the photographic and temperature probe technique which significantly improved the spray field clarity and understanding of reaction mechanisms, (2) the completion of 130 hot fire tests and 10 cold flow tests covering a wide range of operating conditions using an unlike doublet element, two triplet elements, and two platelet elements, (3) the development of RSS correlations for injector design purposes.

1. Task IV Experimental Results

The Task IV test objectives, conditions, and results are summarized in Table VII. The significant results of each group of tests are described below.

The first series of tests were run to improve both the temperature probe technique and the photographic definition of the reactive spray field. It had been found in the Task III

testing that gas density gradients produced by the cold GN_2 purge gas were visible under the high speed photographic conditions. The density gradients obscured the field of view at the higher pressures such that detailed description of the operating mode could not be made. It was reasoned that the density difference between the cold GN_2 and the hot combustion gas could be reduced by using helium in place of nitrogen. Testing with helium purge verified that to be true.

The photographs obtained using Helium purge were significantly clearer than those obtained with the nitrogen purge. However, the cold window permitted condensation of small quantities of fuel. The cost of using helium for the entire test program would have been prohibitive within the cost constraints of the program. Therefore, with the concurrence of the NASA technical monitor, it was decided to test with no purge to evaluate the ability of the hardware to run uncooled. The tests were highly successful in that no hardware damage was incurred and the pictures obtained were of the highest quality ever produced. Therefore, all subsequent tests were run without purge. The improved visibility allowed the mode of operation to be more finely classified. For example, it was possible to identify four distinct modes; mixing, mixing with penetration, mixing with incipient separation and separation as illustrated in Figure 7.

The thermocouple probe was reduced in size from a 0.020 inch (.0508 cm) diameter to a 0.010 inch (.0254 cm) diameter probe as shown in Figure 24. to lessen its influence on the impingement process. Cold flow tests were run with the smaller probe to determine its influence on the spray character. It was found that no visible disruption of the spray was discernible at pressure drops above 10 psi (6.89×10^4 N/m^2). The 0.010 inch (.0254 cm) diameter probe was supported by a 0.020 inch (.0508 cm) diameter sheath for rigidity as shown in Figure 24.

The next three sets of tests were run to determine the influence of chamber pressure, propellant temperature, injection velocity, and fuel type on the impingement point temperature rise (ΔT_i) and RSS. It was initially concluded that these influences on ΔT_i and RSS could be correlated with the Weber number parameter which is discussed in detail in Section IV.E. However, closer examination of the data led to the conclusion that factors accounting for the fuel reactivity must be included.

It was found that the Weber number at which RSS occurs depends on the propellant temperature as shown in Figure 25. The influence of fuel temperature on RSS was believed to be due to the vapor pressure dependence. Increasing propellant temperature increases the vapor pressure and hence the propellant partial pressures and propellant concentrations, making a more reactive vapor mixture. A model of propellant reactivity in terms of a vapor phase mixture ratio is described in Section IV.E. This vapor phase mixture ratio parameter was used to correlate RSS for MMH as previously shown in Figure 5. The A-50 data were found to also be correlated with the Weber number and MR_{VP}.

Visual examination of the movies showed the character of the fuel and oxidizer stream to change with velocity as evidenced by the reflective quality of the stream surfaces. The fuel stream surface was observed to be smooth and highly reflective at fuel velocities below about 67 ft/sec (20 m/sec). The fuel stream appearance transitions to a rough and non-reflective surface at velocities greater than this. It was initially thought that this was evidence of the onset of self atomization due to the Weber number influence. However, cold flow tests, reported in Section V.D.2 will show that the observed behavior corresponds to a transition from laminar to turbulent flow. As discussed in Section V.D.2 the contoured inlet suppreses the transition from laminar to turbulent flow such that transition occurs at a Reynolds number dependent on the orifice

L/D. Transition was predicted to occur at a Reynolds number of 12,500 for the unlike doublet fuel orifice which is in excellent agreement with the experiment. The oxidizer stream exhibited a similar transition in stream surface quality indicating a similar flow transition.

The impingement point temperature rise, ΔT_i, was plotted versus the fuel orifice Reynolds number as shown in Figure 26. These data appear to indicate that there is both a Reynolds number and propellant temperature influence on RSS.

The next series of tests were run using water and freon as propellant simulants to determine the influence of reaction on the observed cyclic nature of stream impingement. It was found that the observed jet shedding and atomization frequencies were the same as observed in the hot fire tests. The fuel orifice transition Reynolds number was also verified.

The final series of tests were run to map the RSS regimes for the X-doublet and splash plate platelet elements and two different sized EDM triplet elements. These elements produced similar trends of RSS with chamber pressure and the dimensionless reactivity parameter, R. The similarity of the trends is reflected by the small differences between the correlation coefficients and exponents shown on Table I. These data indicate parallel trends of minimum chamber pressure for RSS as a function of R. (Constant correlation exponent). Also the intercepts of the correlation equations are within $\pm$ 16% of each other for the three injector types. The data contained in Appendix B show the correlation equations for these injectors to adequately characterize RSS.

2. Cold Flow Results

The unlike doublet elements were cold flow tested during Task III to determine their hydraulic resistance. The results are plotted in Figure 27. The injector resistances determined during Task IV for the two triplet and two platelet injectors are shown in Figures 28 and 29.

The unlike doublet injector was visually observed to flow in an attached mode over the entire flow range as verified by the smooth data plot. It was visually observed that the flow experienced a transition from laminar to turbulent as the pressure drop was increased. The transition occurs at a pressure drop of about 40 psi as shown in Figure 30. The transition from laminar to turbulent flow was not apparent from the cold flow plots of Figure 27, since most of the pressure losses were turbulent entrance and exit losses rather than boundary layer shear losses. The flow model described in Reference 23 predicts that the contoured inlet should suppress transition from laminar to turbulent flow until a Reynolds number based on orifice length of about 300,000 is reached. This corresponds to a Reynolds number based on diameter of about 12,500. The experimental data is in excellent agreement. It was also observed that the onset of self-atomization occurs at a Weber Number of about 12 which is in agreement with that reported in Ref. 24 for droplet breakup.

The fuel orifices in both the small and large triplet elements were also observed to flow attached over the flow range. However, the oxidizer orifices were observed to experience hydraulic flip. The larger oxidizer orifice (D_o = 0.049 inch, .124 cm) detached at a pressure drop of about 25 psi whereas the smaller orifice (D_o = 0.033, .084 cm) detached at about 45 psi (3.1×10^5 N/m^2). The transition from attached to detached flow is apparent in the strobe lighted photographs shown in Figure 31.

Hydraulic flip is a consequence of flowing to ambient backpressure which permits cavitation in the vena contracta. The orifices were observed to flow in the attached mode at the hot test conditions. The only consequence of flowing detached in cold flow is that the discharge coefficients may be significantly less (.6 compared to .8) than for the attached hot fire test conditions. This could lead to errors in predicted hot fire test injector admittance, if not recognized.

The important observation from an RSS standpoint is that the triplets' sharp edged short L/D orifices all exhibit turbulent flow. Another important observation is, that the onset of self-atomization was found to occur at a Weber number of 3 as compared to 12 for the contoured long L/D unlike doublet orifice. The significance of this observation is that it identifies orifice geometry dependence on the onset of self-atomization and/or critical Weber number. It was concluded that turbulent propellant streams will produce greater interfacial surface area on impact than coherent laminar streams such that RSS is expected to be aggravated.

The conclusions drawn from Task IV are:

1. The use of cold window purge gases should be avoided in photographic test chambers.

2. RSS is a gas phase/surface reaction related phenomena which is influenced by injector hydraulics, chamber pressure, fuel type and temperature, and injection velocity.

3. The chamber pressure and injector hydraulics exert the strongest influence on RSS, with RSS increasing with increasing chamber pressure, propellant temperature and propellant stream surface area.

4. The chamber pressure above which severe RSS occurs is predicted by a dimensionless propellant reactivity parameter, R, which accounts for injector hydraulics (through the fuel Reynolds number and the vapor phase propellant through a normalized propellant partial pressure product.

$$R = Re_f x \sqrt{P_{vo} x P_{vf}}/P_o$$

5. Cyclic blowapart (popping) was not observed on any of the tests.

E. Experimental Hardware and Test Setup

1. Test Apparatus

The test apparatus consists of a test chamber equipped with transparent viewing ports and removable injectors and nozzles as shown in Figure 32. The test chamber and an unlike doublet injector were designed and fabricated during the Task III effort. Two triplet and two platelet injectors were designed and fabricated during the Task IV effort.

a. Test Chamber

The test chamber was machined from a 4-inch square x 6-inch long block of 304 CRES. The combustion chamber section is 4 inches (10.16 cm) long, to which a 2 in. (5.08 cm) L* spacer is bolted to increase the combustion zone length to 6 inches (15.2 cm). The block was bored to provide a 2.75 inch (6.99 cm) diameter combustion chamber. Four circular quartz windows were provided to facilitate photography and to allow flexibility in photographic lighting of the combustion process. The windows are 1/2 inch (1.27 cm) thick to provide a safety margin for 1000 psia (6.89×10^5 N/m^2) operation. The flat quartz windows are sandwiched

between durabula gaskets for cushioning against ignition shocks and uneven loading. A silicon "O" ring provides sealing on the window periphery. Quartz windows are used to provide good propellant compatibility and well defined optical properties.

The chamber was designed to provide an inert gas (GN_2) film purge to prevent obscuring the view by propellant spray impingement on the windows. The gas purge flow is injected through four inlets into an annular manifold. The gas is directed from the manifold through an annular gap and made to flow around the periphery of the chamber wall. The gas passages were sized such that the GN_2 is injected into the chamber at 50 ft/sec (15.2 m/sec) at 300 psia (2.07×10^6 N/m^2) chamber pressure to minimize mixing with the propellant spray and combustion gas. Subsequent testing showed that the cold GN_2 purge gas causes poor spray field visibility due to the density gradient created between it and the hot combustion gas. A significant improvement in visibility was made by matching the purge gas density to the combustion gas density by using a cold helium purge. However, the best photographs were obtained with no purge at all.

Provision was made for mounting both high and low frequency response pressure transducers and thermocouples. The nozzles consist of removable copper inserts drilled to provide the desired operating pressures.

b. Injectors

(1) Task III Injectors

The injector body was made in a cylindrical "piston" shape as shown in Figure 33 to fit into the chamber purge ring located at the forward end of the chamber. The injector is held in the purge ring by allen head screws. A silicon rubber O-ring seals the injector to the purge ring.

The injector consists of a main body with brazed-on inlet tubes. The injectors were made of 304 CRES to permit braze assembly and provide dimensionally stable orifices. Two injector patterns were incorporated in one body as shown in Figure 33 to reduce fabrication costs. The unlike doublet element design parameters are included in Figure 33. The orifice L/D's were made long (24/1) with rounded inlets to provide controlled hydraulics.

The injector orifices were flow tested prior to the Task III hot fire testing to measure Kw's and to verify impingement accuracy. The flow data are discussed in Section V.D.2. Subsequent cold flow tests were run during Task IV to characterize the rounded inlet orifice hydraulics. Results of these tests are also discussed in Section V.D.2.

A high frequency response Kistler pressure transducer mounting port was provided in the long impingement doublet as shown in Figure 33 to measure impingement point disturbances. This port was also used to install a high response thermocouple for measuring the impingement point temperature rise.

(2) Task IV Injectors

The triplet element and the self-atomizing platelet element were selected for test evaluation during Task IV. Two different triplet injectors were designed to evaluate the influence of orifice diameter on RSS. The larger triplet element uses 0.030 inch (.076 cm) diameter fuel orifices and the smaller one uses 0.020 (.05 cm) inch dia. fuel orifices. The design details are shown in the schematic of Figure 34. Both elements were FDM machined into the same injector body to reduce fabrication costs. Separate propellant inlets were provided.

The orifices were designed with short L/D's and sharp edged inlets to simulate typical rocket injector orifice hydraulics. The results of a cold flow evaluation of the triplet injectors are discussed in Section V.D.2.

The X-doublet and the splash plate self atomizing platelet elements shown in Figure 35 were selected for test evaluation. Both elements were photoetched into the same platelet stack for minimum cost. The platelet stack was bolted to an injector body provided with a single set of propellant inlets. Manifolding of the desired element was accomplished by rotation of the platelet stack. "O" rings were used to seal the platelet stack propellant passages to the injector body.

The X-doublet element consists of a parallel self-atomized fuel and a parallel self-atomized oxidizer stream placed in close proximity to one another such that mixing occurs by parallel stream momentum exchange. Self-atomization is accomplished by self-impingement within the platelet stack as shown in Figure 35. The resultant atomized stream is ejected perpendicularly from the platelet stack. The splash plate element consists of one self-atomized fuel stream impinging on one self-atomized oxidizer stream as shown in Figure 35. The self-atomization is produced by impinging the propellant stream against a splash plate as shown in Figure 35.

2. <u>Hot Fire Test Facility Setup</u>

The test apparatus was setup in the Research Physics Laboratory Test Bay 2 shown in Figure 36.

A schematic of the propellant system used is shown in Figure 37. Propellant (MMH/A-50/NTO) is stored in 50-gallon, 3000-psi run vessels. Gaseous nitrogen pressurization of these systems was used to provide controlled run conditions over a wide range of injector and chamber pressures.

Propellant conditioning was provided by installing in-line heat exchangers immediately upstream of the thrust chamber valves. A hot water circulation type temperature conditioning system was used to provide independent conditioning of the ox and fuel to temperatures from ambient to 300°F.

A separately regulated GN_2 supply was used to provide test chamber back pressure as well as provide window purge for the chamber viewports during the Task I testing. The window purge was eliminated early in the Task IV testing to improve photographic quality as discussed in Section V.D.1.

3. Cold Flow Test Setup

The cold flow tests were also conducted in the Research Physics Laboratory. Filtered, de-ionized water was used as the test fluid on most tests. Pressure measurements were made using Heise gages and flow rate was calculated using a time/volume technique, with run times of from 60 to 200 seconds. On some tests strobe light photographs were obtained in order to better evaluate propellant stream properties. Selected tests also were made with dyed water and freon as the test fluids in order to evaluate stream impingement characteristics.

4. Hot Fire Instrumentation

High speed color photographs of the spray field were taken with the photographic equipment shown in Figure 36. Pictures were taken over a wide range of exposures, from 8000 pictures per second (1.25 μ sec exposure) down to 400 PPS (25 μ sec exposure) with a Hycam Model 41-0004 high speed camera. Four hundred foot rolls of Ecktachrome EF No. 7242 film were used which allows approximately 0.6 sec. of constant speed frame rate at 8000

PPS and approximately 30 sec. constant speed at 400 PPS.

Lighting of the spray field was accomplished with the use of three 1000-watt quartz iodine lamps focused with Fresnel lenses. One lamp was used to backlight the spray area with the second and third lamps used as top and front lighting to provide spray detail and definition.

The lighting was improved during the Task IV testing by replacing the front and top lights with smaller 750 watt lamps and adding another lamp to light the bottom port. The smaller lamps were placed within one inch of the top and bottom windows to maximize the illumination. The net effect was to improve the balance between the front lighting and the back lighting.

The high frequency and low frequency instrumentation listed in Tables VIII and IX were used in the locations shown in the schematic of Figure 38.

Low frequency response test parameters were recorded on a Consolidated Electrodynamic Corporation's direct writing oscillograph. The high frequency response data were recorded on a Sangamo Model 3564 analog tape recorder.

The operating point data indicated in Table IX were digitized and stored in the on-line HP 2100 A Computer/Real Time process controller for "quick look" test review.

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TABLE I. RSS CORRELATION CONSTANTS

FUEL	INJECTOR DESCRIPTION	a	b	FIGURE NO. SHOWING CORRELATION
MMH	Unlike Doublet - Rounded Inlet	3300	-0.447	1, B-1, B-2, B-3
A-50	Unlike Doublet - Rounded Inlet	3300	-0.447	B-4
N_2H_4	Unlike Doublet - 100/1 L/D	387	-0.05	B-5, B-6, B-7, B-8
MMH	Triplet	255	-0.05	B-9, B-10
MMH	X-Doublet	206	-0.05	B-11, B-12, B-13
MMH	Splash Plate	193	-0.05	B-14
MMH	V-Doublet	157	-0.05	B-15, B-16, B-17
MMH	Like-on-Like	125	-0.05	B-18, B-19, B-20, B-21

Correlation Equation:

$$P_{c_{RSS}} = a R^b$$

where:

$P_{c_{RSS}}$ =

$R = Re_f \sqrt{\frac{P_{vo} \times P_{vf}}{P_c}}$

Re_f = Fuel orifice Reynolds Number

P_c = Chamber Pressure, psia

P_{vo}, P_{vf} = Oxidizer and fuel vapor pressure

TABLE II

RSS STUDY PARAMETER SUMMARY

PARAMETER	RANGE INCLUDED IN STUDIES
Propellant Combination	N_2O_4/N_2H_4, N_2O_4/MMH, N_2O_4/A-50, N_2O_4/UDMH, N_2O_4/M-50, N_2O_4/Furfuryl Alcohol, IRFNA/UDMH, ClF_5/N_2H_4
Element Type	Unlike Doublet, Like Doublet, Quadlet, F-O-F and O-F-O Triplets
Element Size	.020 to .236 in. Dia. (.051 - .599 cm)
Element Mixing Efficiency	0.1 to 1.0
Element Spacing	Not Specified
Injection Velocity	5 to 145 ft/sec (1.5 - 44.2 m/sec)
Chamber Pressure	Atmospheric to 500 psia (3.44×10^6 N/m^2)
Fuel Temperature	40 to 250°F (278 - 394°K)
Oxidizer Temperature	-10 to 140°F (250 - 333°K)
Mixture Ratio	0.5 to 3.0
Stream Dynamic Pressure Ratio	0.3 to 8.0 Fuel/Oxidizer

TABLE III

COMPARISON OF HEAT RELEASE RATES AND VAPOR PRESSURE

Fuel	P_V at 100°F, (311°K) psia (N/m^2)	Heat Release Rate Kcal/sec-mole of NTO
N_2H_4	0.65 (4.47×10^3)	4×10^4
UDMH	5.9 (40.7×10^3)	14×10^4
MMH	1.9 (13.1×10^3)	20×10^4

TABLE IV

PREDICTED AND MEASURED RSS PRESSURE LIMITS

Fuel	P_V at 100°F (311°K) psia (N/m^2)	Predicted Limit psia (N/m^2)	Measured* Limit psia (N/m^2)	Orifice Type
N_2H_4 ***	.65 (4.47×10^3)	300 (2.07×10^6)	300 (2.02×10^6)	Unlike Doublet L/D = 100
MMH	1.9 (40.7×10^3)	400 (2.76×10^6)	150 (1.03×10^6)	Unlike Doublet L/D = 24**
A-50	4.5 (13.1×10^3)	500 (3.45×10^6)	200 (1.38×10^6)	Unlike Doublet L/D = 24**

*Ambient temperature propellants

**Contoured Inlets

***Zung, Ref. 27

TABLE V

TASK III TEST OBJECTIVES AND RESULTS

TEST OBJECTIVE	FUEL	INJECTOR	T_o (°F)	T_F (°F)	P_c (PSIA)	NO. TESTS	RESULTS
CHECKOUT TESTS	MMH	LONG IMPING.	AMB	AMB	300-1000	6	ALL SHOWED SEP.
DETERMINE PRESSURE LIMIT FOR RSS	MMH	LONG IMPING.	AMB	AMB	100-300	5	SEP ABOVE 150 PSI
DETERMINE VAPOR PRESSURE EFFECT ON RSS	A-50	LONG IMPING.	AMB	AMB	100-1000	12	SEP ABOVE 200 PSI
DETERMINE EFFORT OF IMPING. LENGTH ON RSS	MMH	SHORT IMPING.	AMB	AMB	100-1000	9	NO DISCERNIBLE DIFFERENCE
DETERMINE EFFECT OF TEMPERATURE ON RSS	MMH	LONG IMPING.	AMB	200	100-250	5	SEP AT 100 PSI
MEASURE IMPINGEMENT POINT TEMPERATURE	MMH	LONG IMPING.	AMB	AMB	100-1000	14	IMPING. PT. TEMPERATURE IS VELOCITY & PRESSURE DEPENDANT

TABLE VI

COMPARISON OF HEAT RELEASE RATES AND RSS LIMIT

Fuel	Heat Release Rate Kcal/sec-mole of NTO	Measured RSS Limit psia, N/m^2
N_2H_4	4×10^4	300 (2.07×10^6)
A-50	-	200 (1.38×10^6)
UDMH	14×10^4	-
MMH	20×10^4	150 (1.03×10^6)

TABLE VII

TASK IV - TEST OBJECTIVES AND RESULTS

Test Objective	Fuel	Injector	D_f (in)	T_o (°F)	T_F (°F)	P_c (psia)	ΔP_f (psi)	No. of Tests	Results
Improve Photography & T/C Probe Technique	MMH	Unlike Doublet	0.020	70	70	100-300	30-100	10	1. Best pictures are obtained without GN_2 Purge 2. Helium purge is better than GN_2 purge. 3. 0.010 in. dia. T/C Probe provides reliable T_i with minimum disruption.
Propellant Temp Effect on T_i	MMH	Unlike Doublet	0.020	70-124	70-200	100-200	30	8	Temperature appears to influence ΔT_i through propellant property changes.
Velocity Effect on T_i	MMH	Unlike Doublet	0.020	Amb	Amb	100-300	10-100	27	Velocity and chamber pressure exhibit controlling influe_e on ΔT_i & RSS
Fuel Effect on T_i	A-50	Unlike Doublet	0.020	Amb	Amb	100-500	20-150	20	Fuel effect can be correlated with vapor phase mixture ratio
Jet Shedding Freq.	Water	Unlike Doublet	0.020	Amb	Amb	14.7	10-100	10	Jet Shedding frequencies same as hot fire
Map RSS	MMH	XDT1-Platelet	0.021	70-150	70-290	80-150	20-125	16	
Map RSS	MMH	Splash Plate Platelet	0.021	70-150	70-290	80-150	20-125	15	
Map RSS	MMH	Triplet	0.029	70-150	70-290	80-150	20-125	11	
Map RSS	MMH	Triplet	0.020	70-150	70-290	80-150	20-125	12	
*Map RSS	MMH	Unlike Doublet	0.020	70-150	70-290	80-150	20-125	11	RSS correlates with Weber Number and vapor phase MR
								140	

* Bonus Tests

TABLE VIII

HIGH FREQUENCY RESPONSE INSTRUMENTATION

Test Parameter	Symbol	Instrument Make	Model	Range	Accuracy
Oxidizer Manifold Pressure	POJHF	Kistler	601	0-3000 psi (P-P)	± 0.5%
Fuel Manifold Pressure	PFJHF	Kistler	601	0-3000 psi (P-P)	± 0.5%
Chamber Pressure	PCHF	Kistler	601	0-3000 psi (P-P)	± 0.5%
Injector Acceleration	ACC	-	-	0-500 g's	± 0.5%
Injector Probe Temperature	TP1	C/A		0-500 °F	± 1%

TABLE IX

LOW FREQUENCY RESPONSE INSTRUMENTATION

TEST PARAMETER	SYMBOL	RANGE	UNITS	RECORDER "O" GRAPH	RECORDER TAPE	RECORDER DIGITAL
Oxid. Tank Pressure	POT	0-1500	PSIA	X		
Fuel Tank Pressure	PFT	0-1500	PSIA	X		
Oxid. Injector Pressure	POJ	0-1500	PSIA	X		X
Fuel Injector Pressure	PFJ	0-1500	PSIA	X		X
Chamber Pressure	PC	0-1000	PSIA	X		X
Window Purge Pressure	PNZ	0-2000	PSIA	X		X
Oxid. Flowrate	WO	0-0.1	LB/SEC	X		X
Fuel Flowrate	WF	0-0.1	LB/SEC	X		X
Oxid. Flowmeter Temp.	TOFM	0-500	^{o}F	X		X
Fuel Flowmeter Temp.	TFFM	0-500	^{o}F	X		X
Oxid. Injector Temp.	TOJ	0-500	^{o}F	X		
Fuel Injector Temp.	TFJ	0-500	^{o}F	X		
Oxid. Valve Voltage	VOV			X		
Fuel Valve Voltage	VFW			X		
Wind Purge Valve Voltage	VWPV			X		
Camera Voltage	VCAM			X	X	
Injector Purge Valve Voltage	VIPV			X		

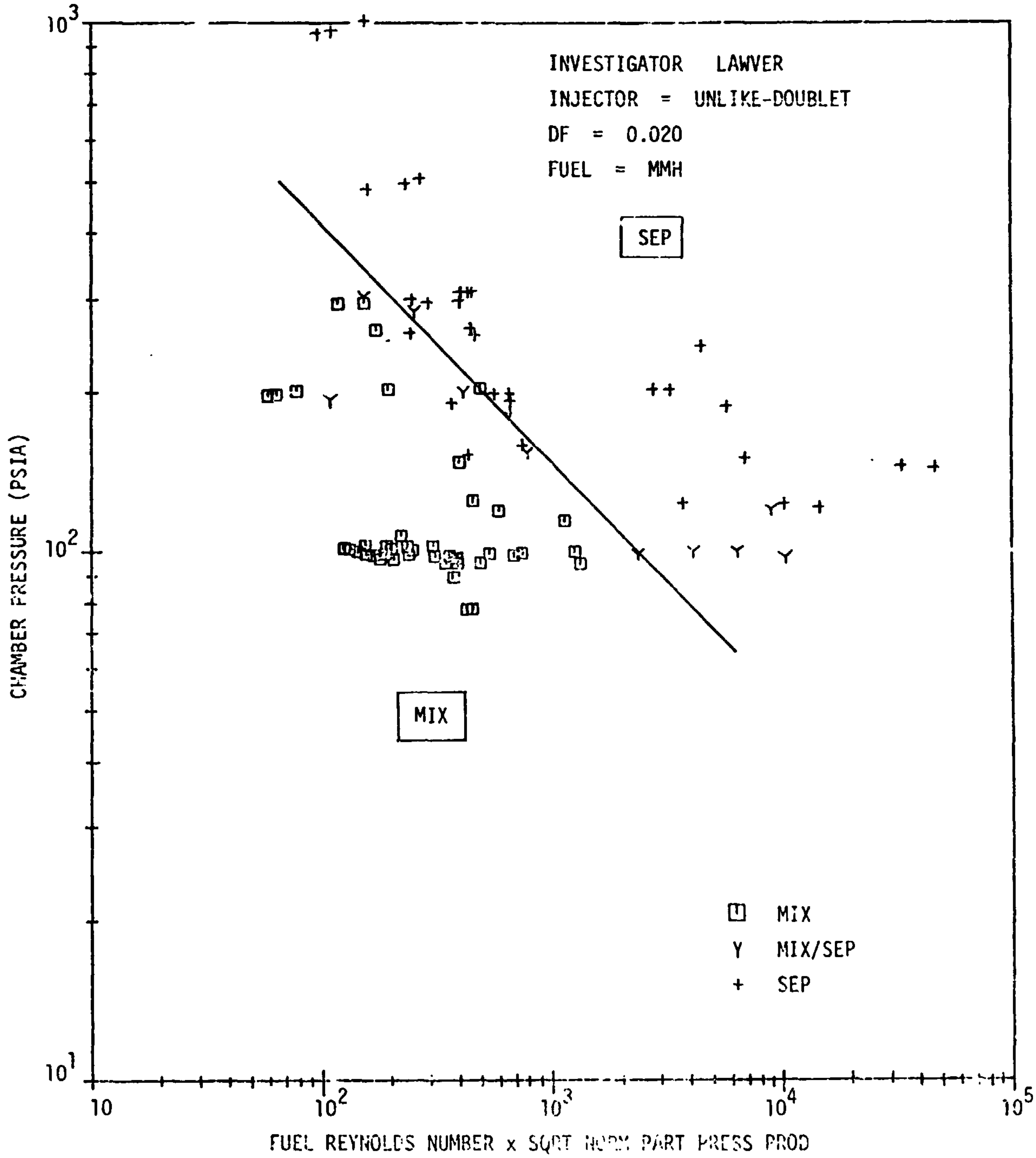


Figure 1. Effect of Chamber Pressure and Reactivity on RSS

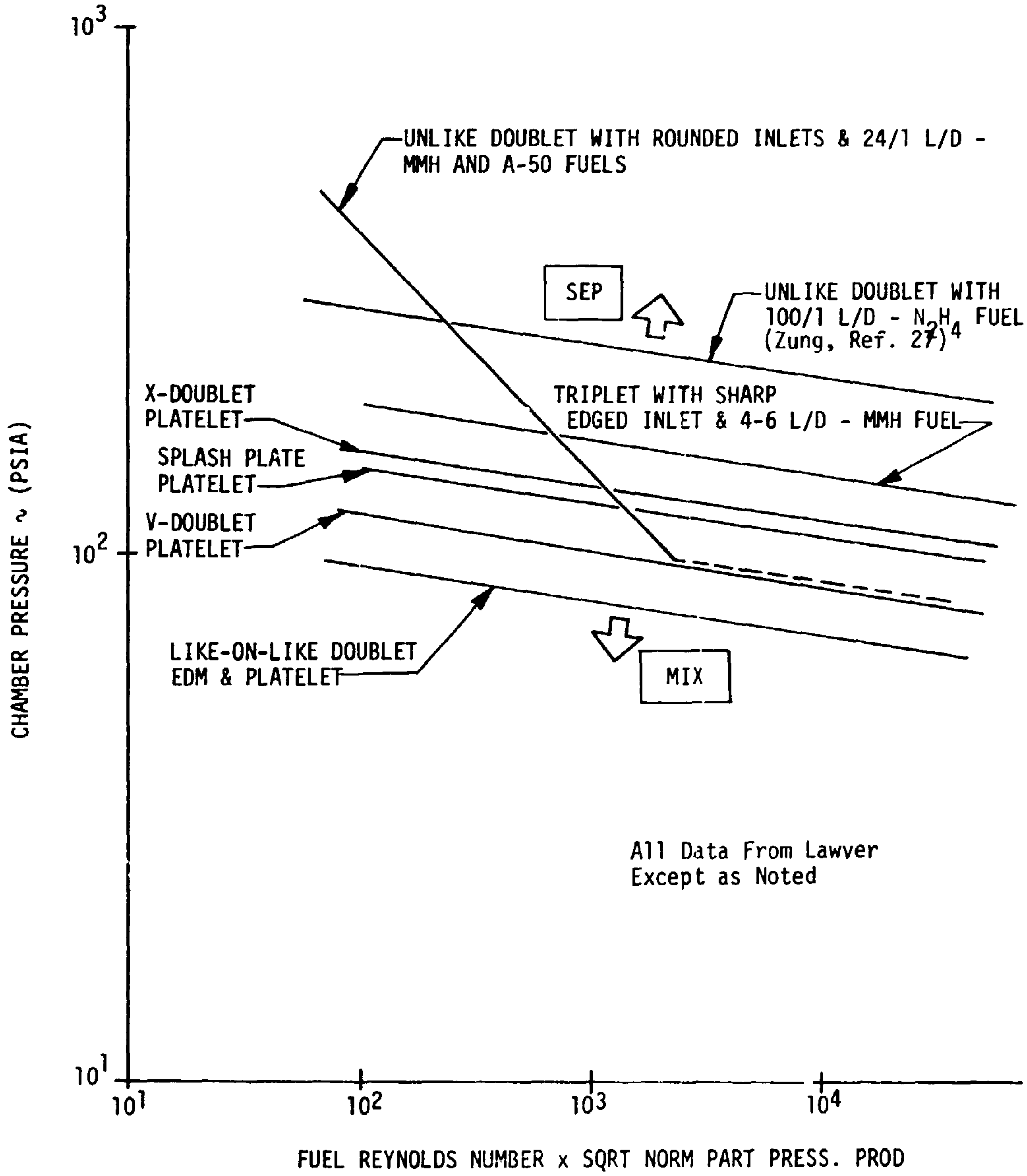
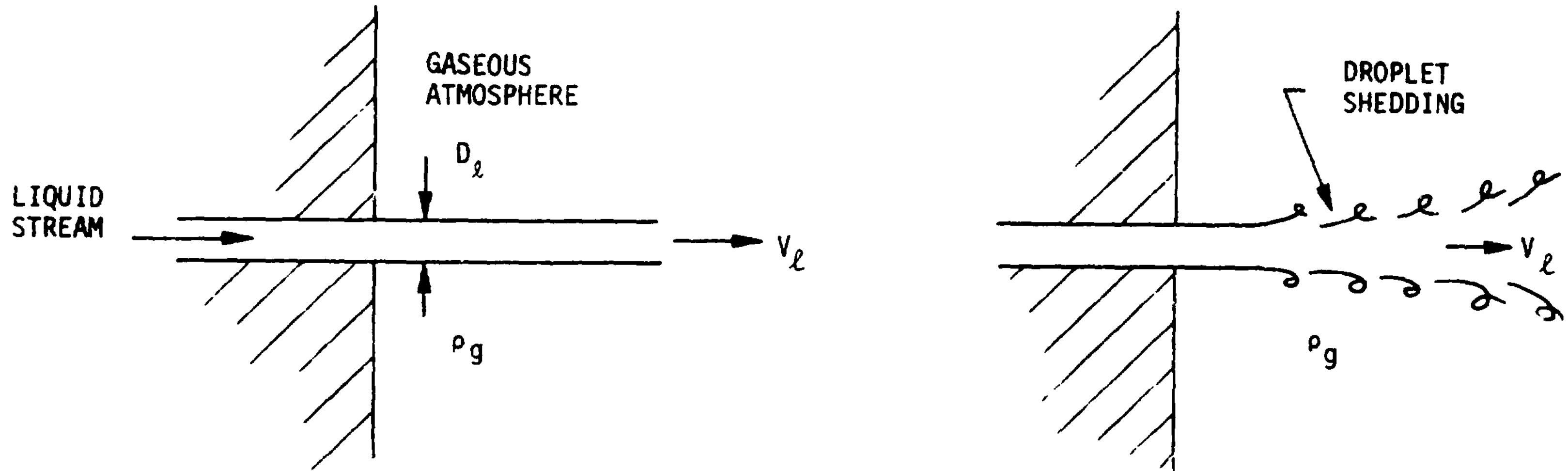


Figure 2. RSS Correlation Plot



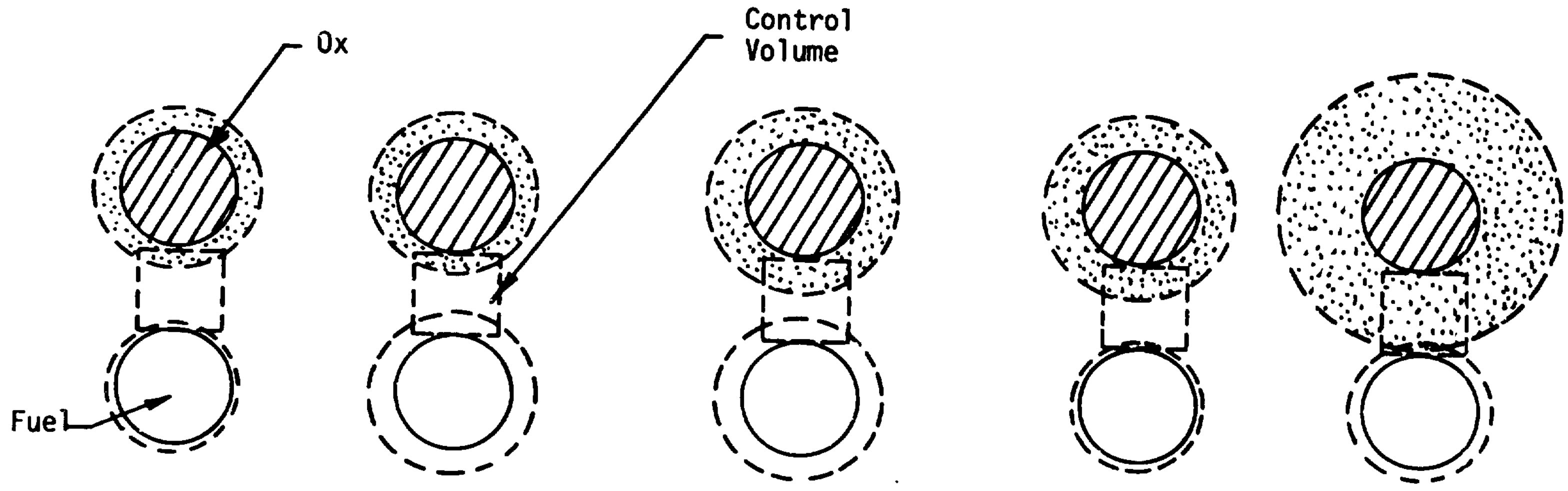
$W_e < W_{e_{critical}}$ $\qquad\qquad$ $W_e > W_{e_{critical}}$

W_e = AERODYNAMIC SURFACE FORCE / SURFACE TENSION

$$W_e = \frac{\rho_g \, \Delta V_\ell^2 D_\ell}{\sigma_\ell \, g_c} \qquad\qquad \rho_g = \frac{P_c}{R_c T_c}$$

$$W_{e_{crit}} = \text{[illegible]} + \left(\frac{\mu_\ell^2}{\rho_\ell \, D_\ell \quad \sigma_\ell g}\right)^{0.36}] \quad \text{(Ref. 24)}$$

Figure 3. Weber Number Model



P_c = Moderate				P_c = Low
T_F = Amb	T_F = Hot	T_F = Hot	T_F = Amb	T_F = Amb
T_{ox} = Amb	T_{ox} = Amb	T_{ox} = Hot	T_{ox} = Hot	T_{ox} = Amb
MR = High	MR = Low	MR = Intermediate	MR = High	MR = High
Surface Reaction	Vapor Phase Reaction	Vapor Phase Reaction	Surface Reaction	$P_{vox} \geq P_c$

Figure 4. Vapor Phase Reaction Model

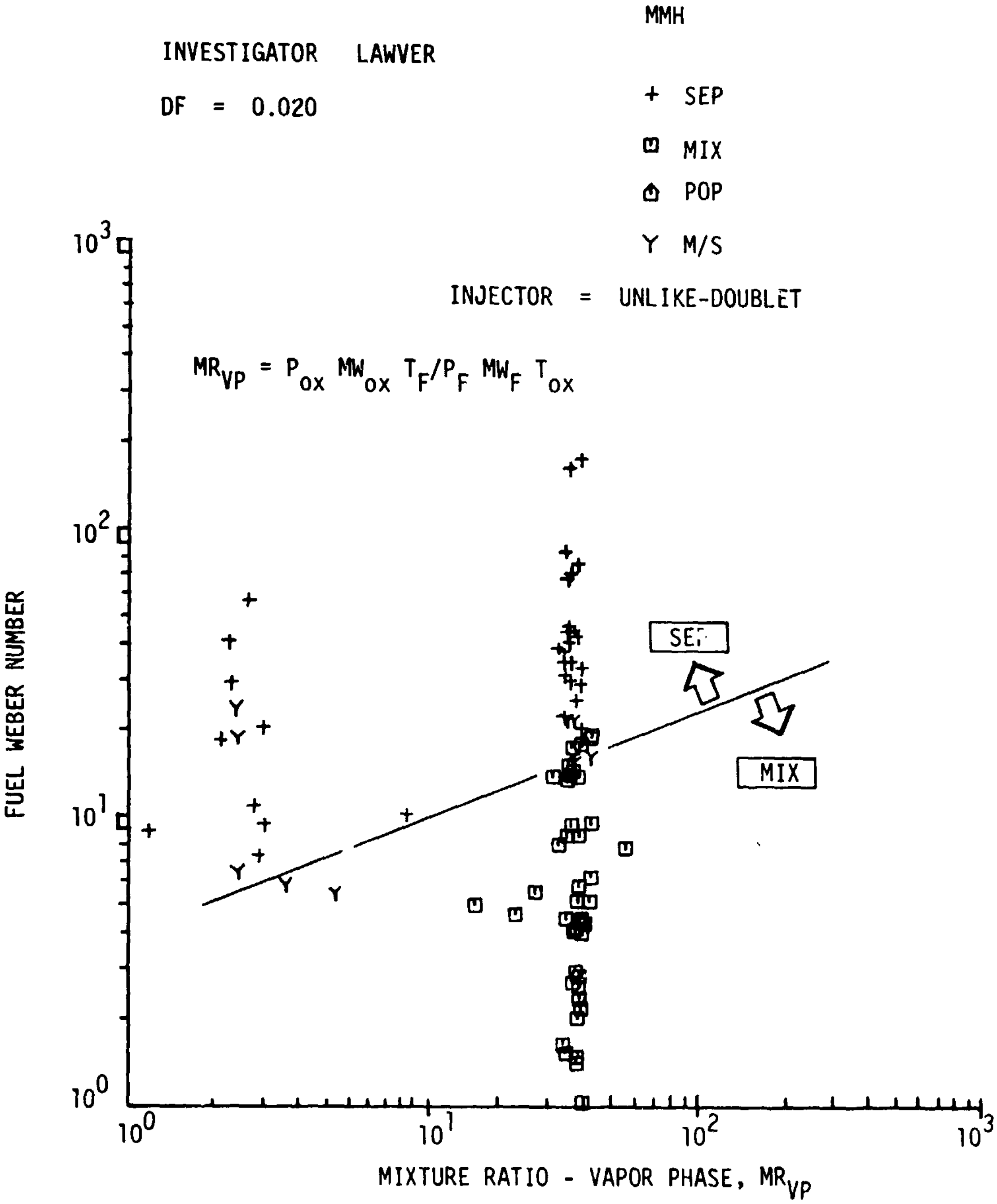
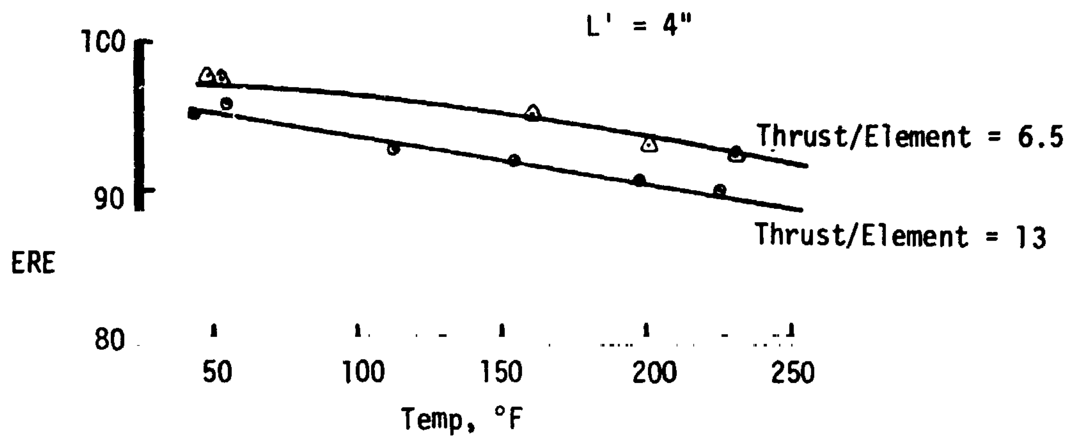


Figure 5. Effect of Fuel Weber No. and Vapor Phase Mixture Ratio on RSS



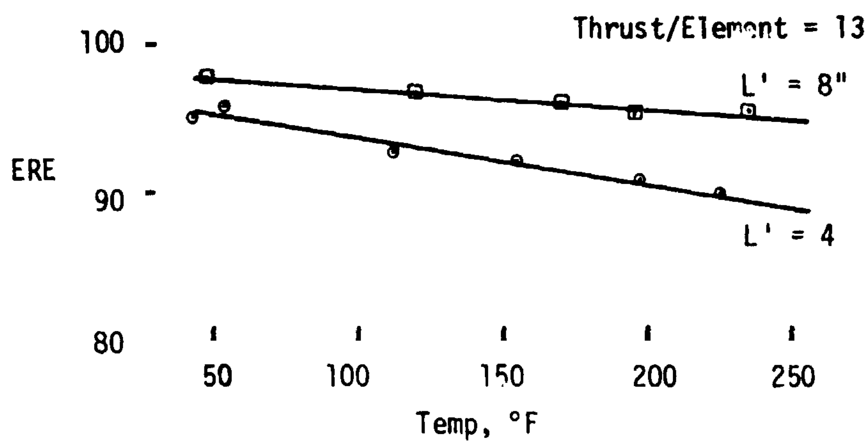
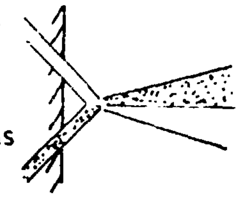


Figure 6. Effect of Fuel Temperature on ERE

• PENETRATED - Injection process results in the penetration of the fuel and oxidizer with propellants unmixed on the opposite side of the element. Same effect on combustion efficiency as separated flow regime.

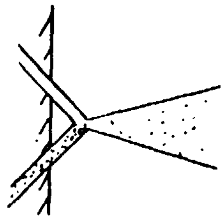


Low Reactivity Propellants

Small Orifice Size

Low Injection Velocity

• MIXED - Injection process results in uniform mixture of fuel and oxidizer and high combustion efficiency.



Lower Propellant Temperatures

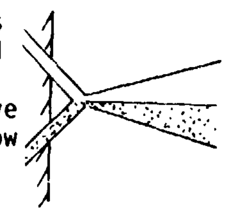
Lower Reactivity Propellants

Smaller Orifice Size

Unequal Stream Dynamic Pressures

• PENETRATED/MIXED - Injection process results in some propellant penetration, but with a mixed region also.

• SEPARATED - Injection process results in the separation of fuel and oxidizer before mixing with the propellants remaining in their respective side of the element. Results in a low combustion efficiency which will improve to some degree with increasing chamber length.



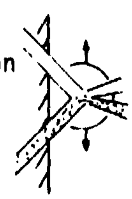
High Fuel Temperature

High Oxidizer Temperature (oxidizer vaporization)

Highly Reactive Propellants

Larger Orifice Size

• POPPING - Cyclic blowapart of a single element or the spray detonation of a large group of elements. Random occurrence which could lower the overall time averaged combustion efficiency and effect combustion stability.



Lower Propellant Temperatures

Lower Chamber Pressure

Larger Orifice Size

Higher Contact Time (D/V)

Reactive Propellants

Equal Stream Dynamic Pressures

Figure 7. Reactive Stream Impingement Regime

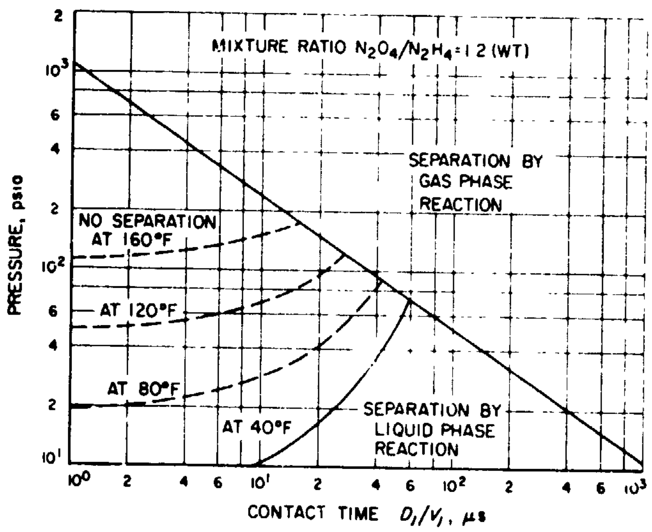


Figure 8. Predicted RSS Limits - JPL Model

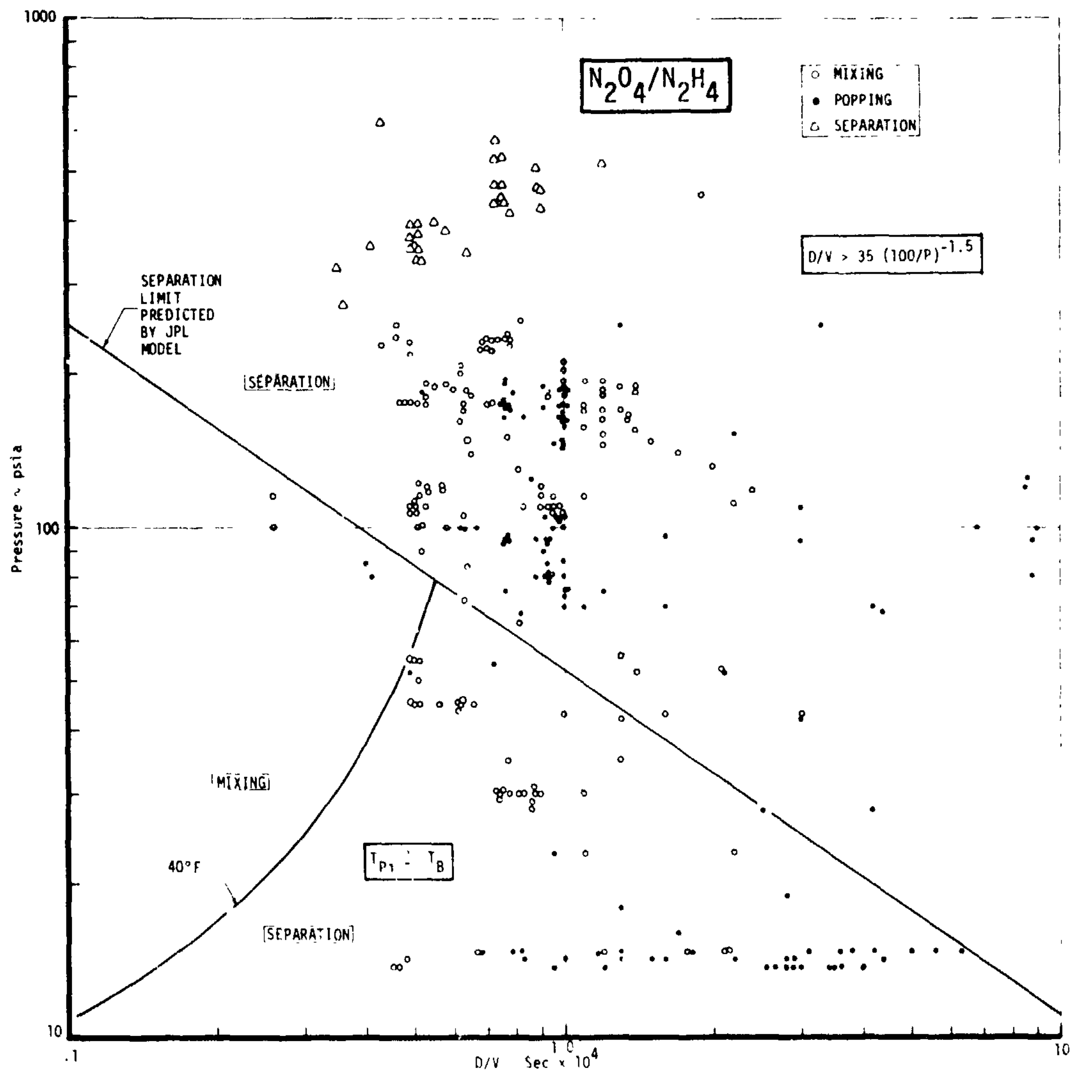


Figure 9. RSS Data Correlation - JPL Model

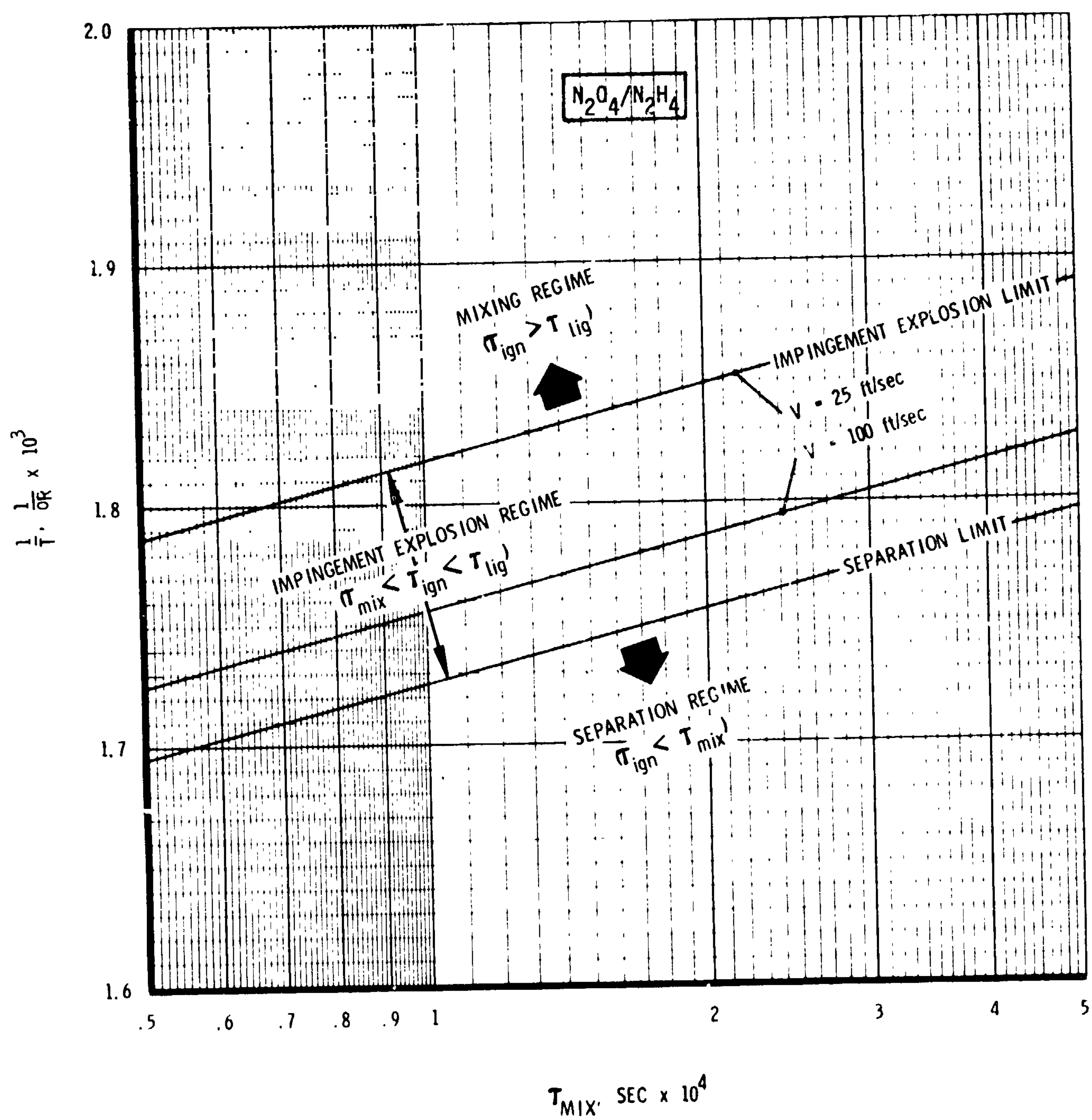


Figure 10. Predicted RSS and Pop Limits - ALRC Model

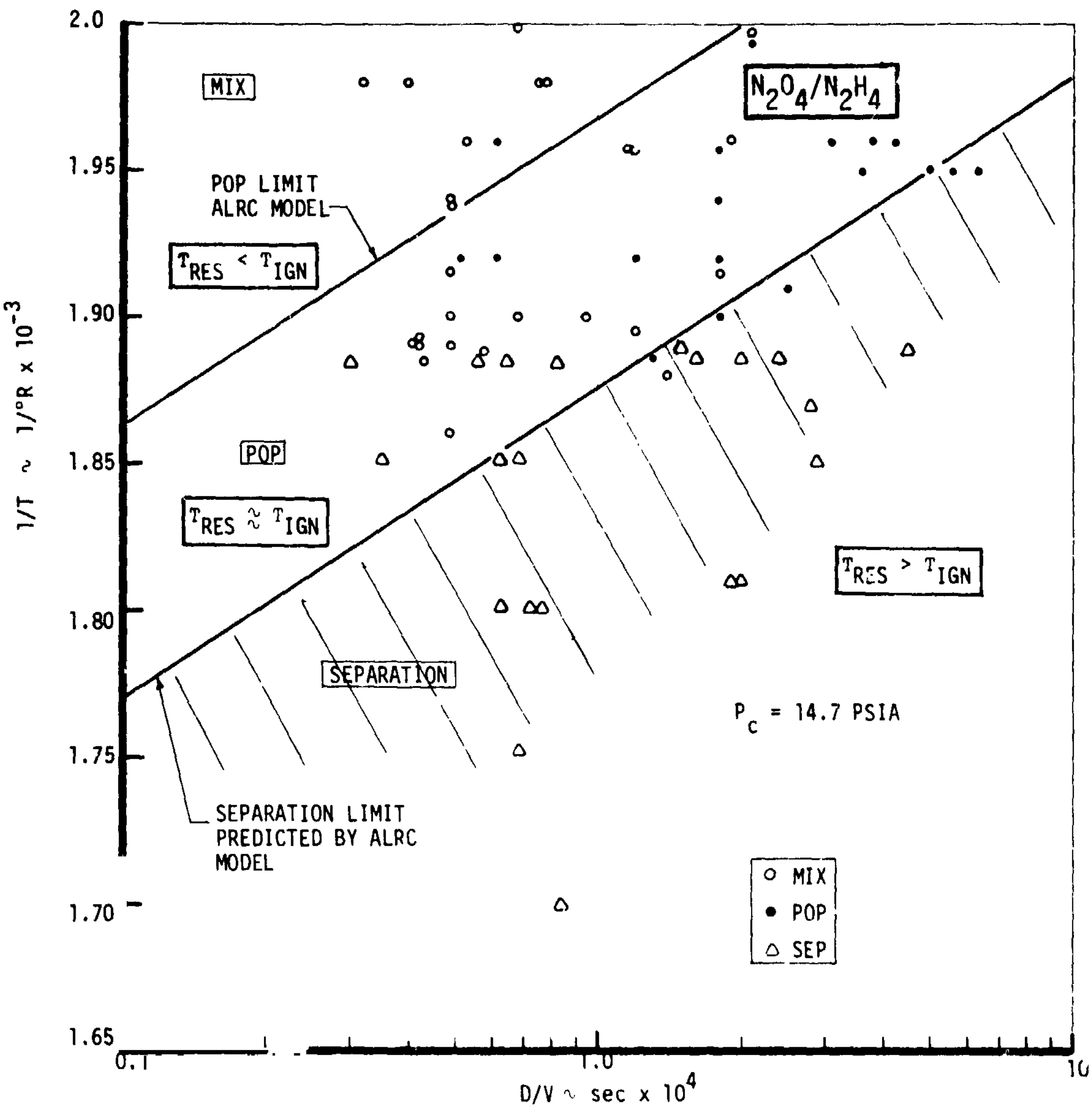


Figure 11. RSS and Pop Data Correlations - ALRC Model

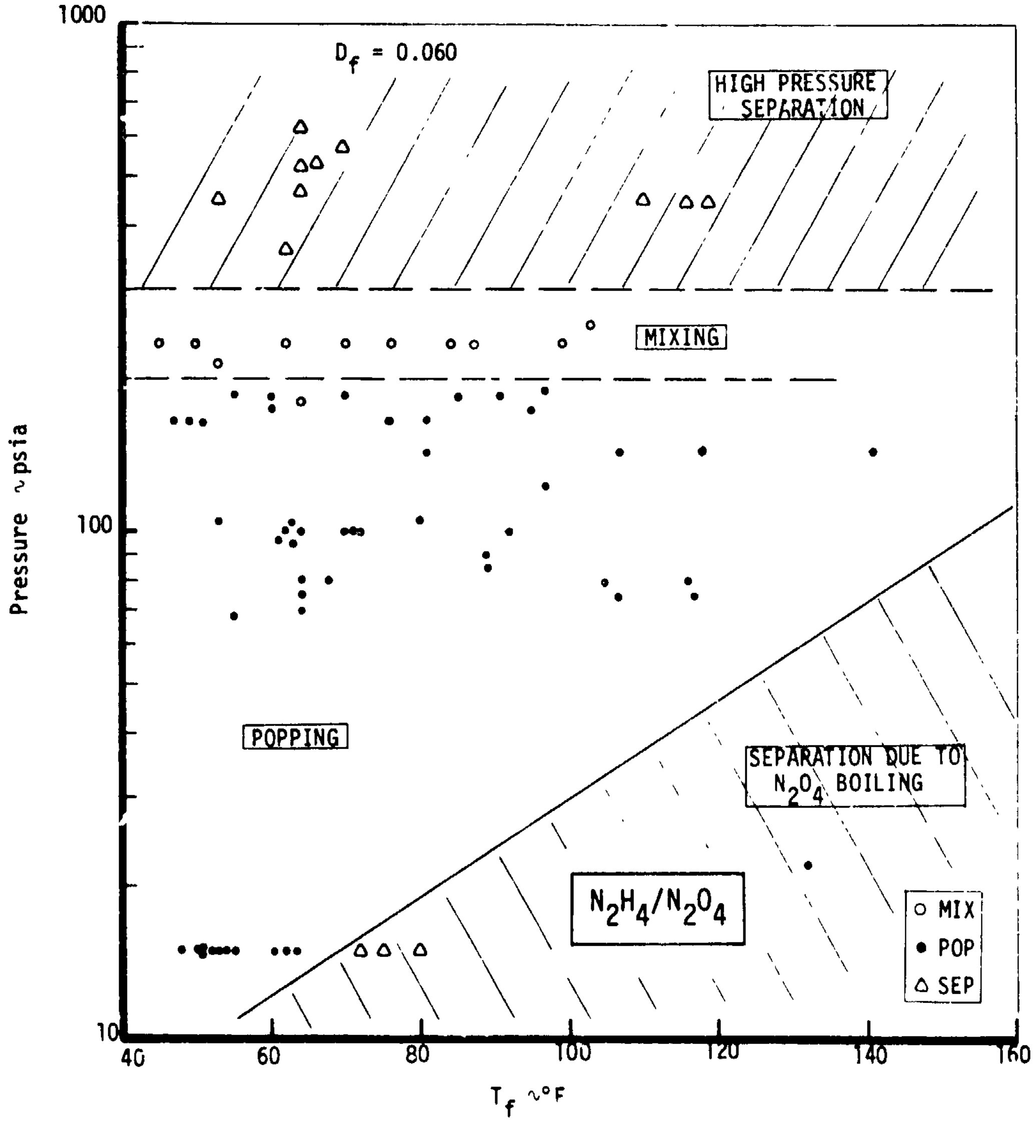


Figure 12. Pressure vs Temperature - D_f = 0.060

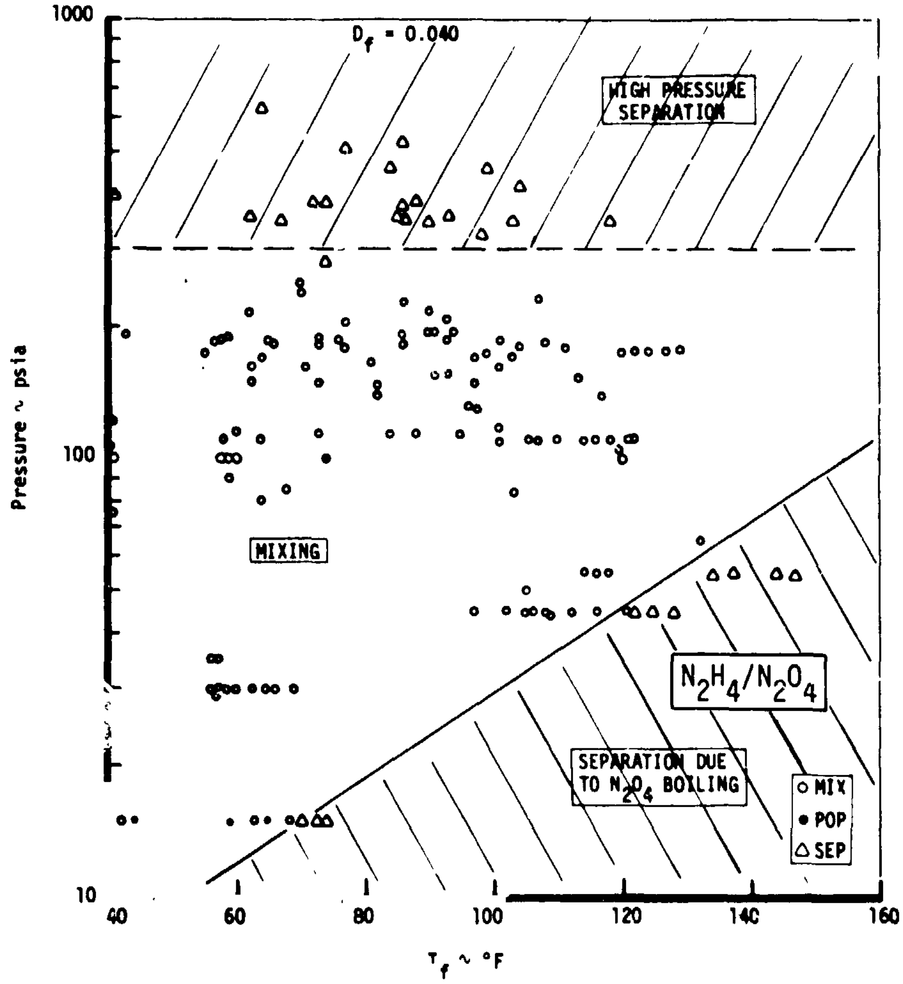


Figure 13. Pressure vs Temperature - D_f = 0.040

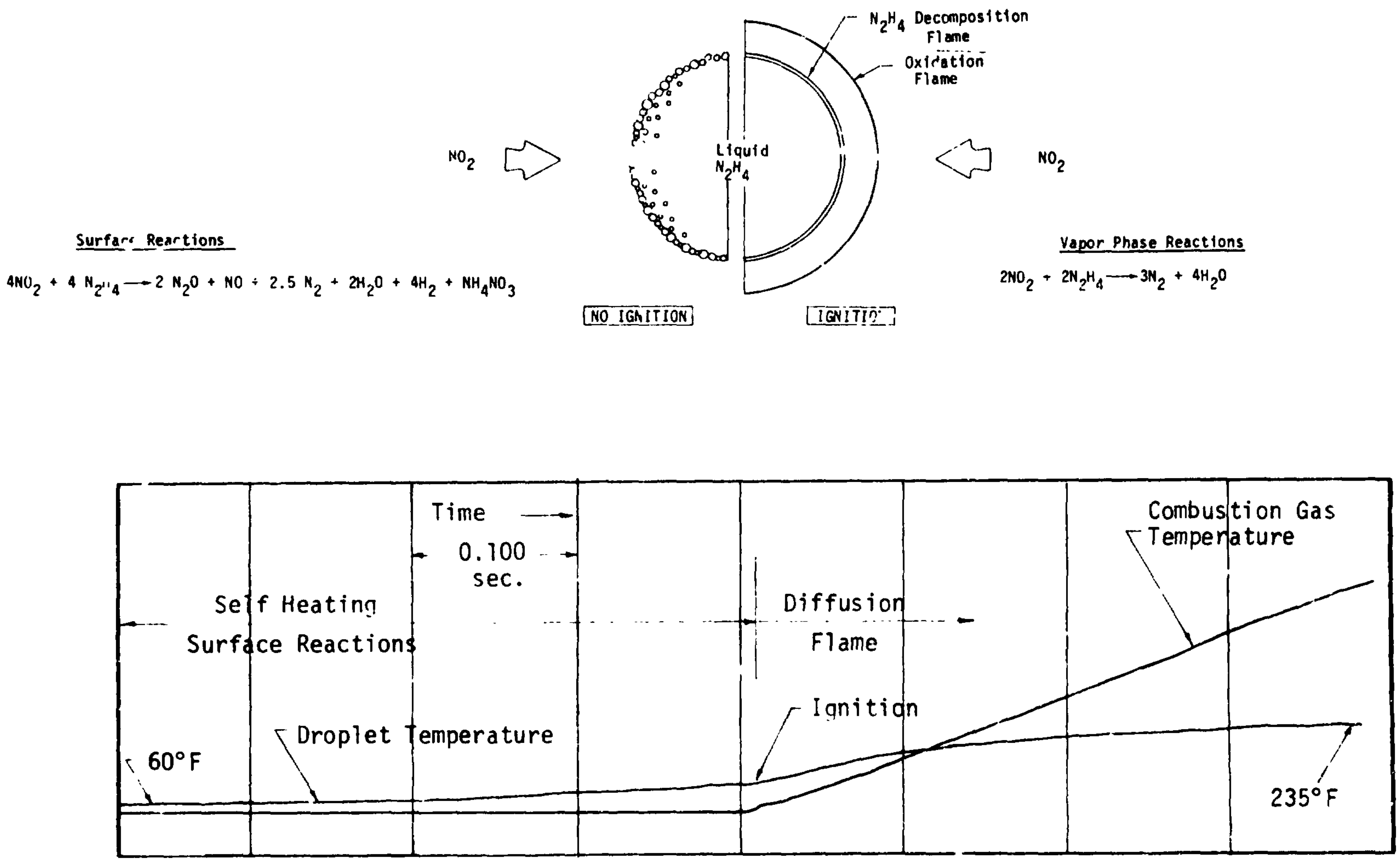


Figure 14. Hypergolic Ignition Process

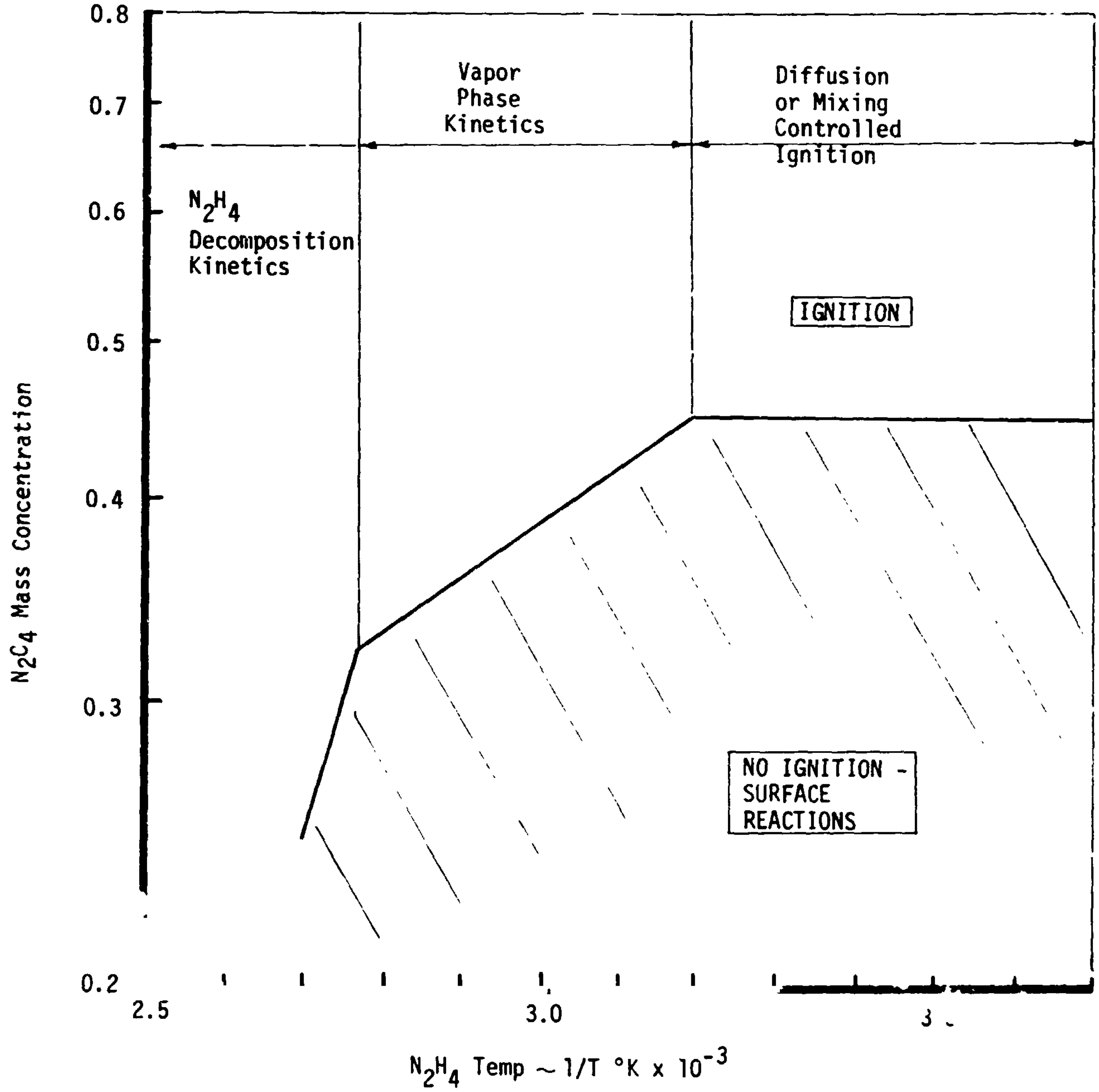
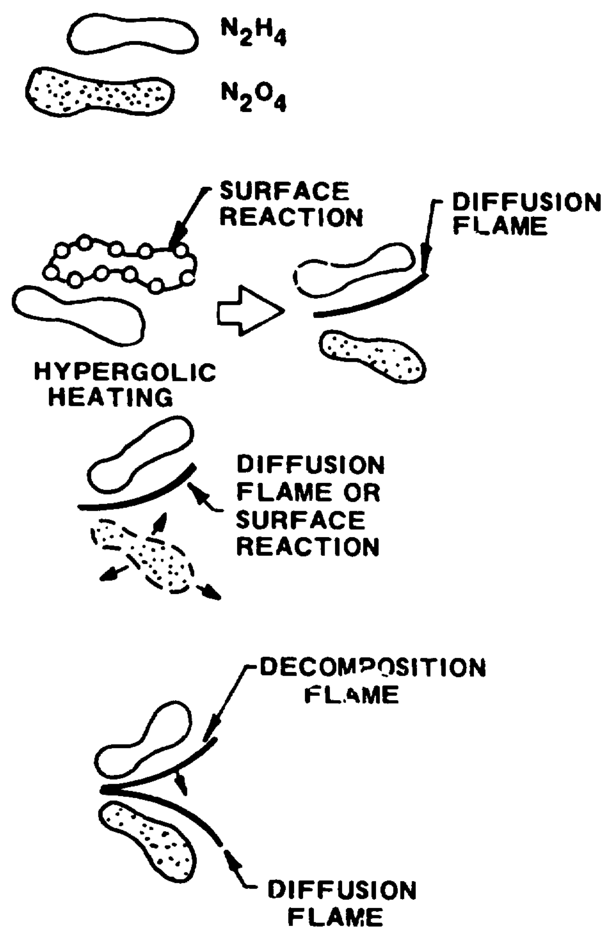


Figure 15. N_2H_4/N_2O_4 Ignition Limits



<u>MIXING REGIME</u>

VAPOR PHASE REACTION CONTROLLED

- HIGHER PRESSURE
- SMALLER ORIFICE DIAMETER
- LOWER PROFELLANT TEMP.

<u>POPPING REGIME</u>

SURFACE REACTION CONTROLLED

- LOWER PRESSURE
- LARGER ORIFICE DIAMETER
- LOWER TEMP.

<u>LOW PRESSURE SEPARATION REGIME</u>

N_2O_4 VAPOR PRESSURE CONTROLLED

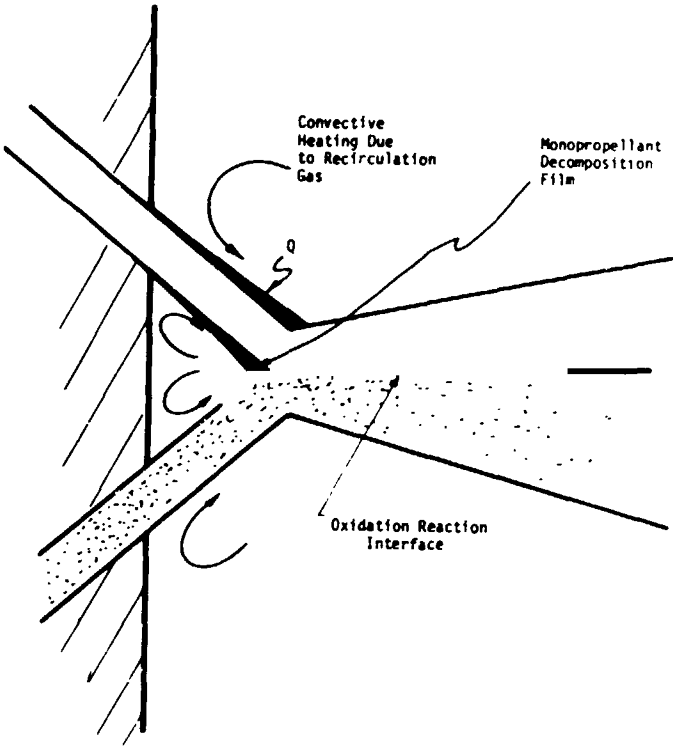
- LOWER PRESSURE
- HIGHER TEMP.

<u>HIGH PRESSURE SEPARATION REGIME</u>

MONOPROPELLANT DECOMPOSITION CONTROLLED

- HIGHER PRESSURE

Figure 16. Postulated RSS and Pop Controlling Mechanisms



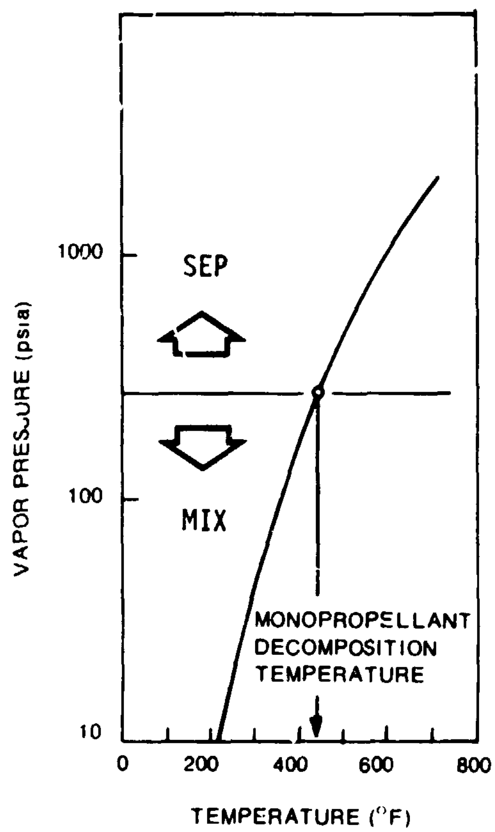


Figure 17. High Pressure RSS Model

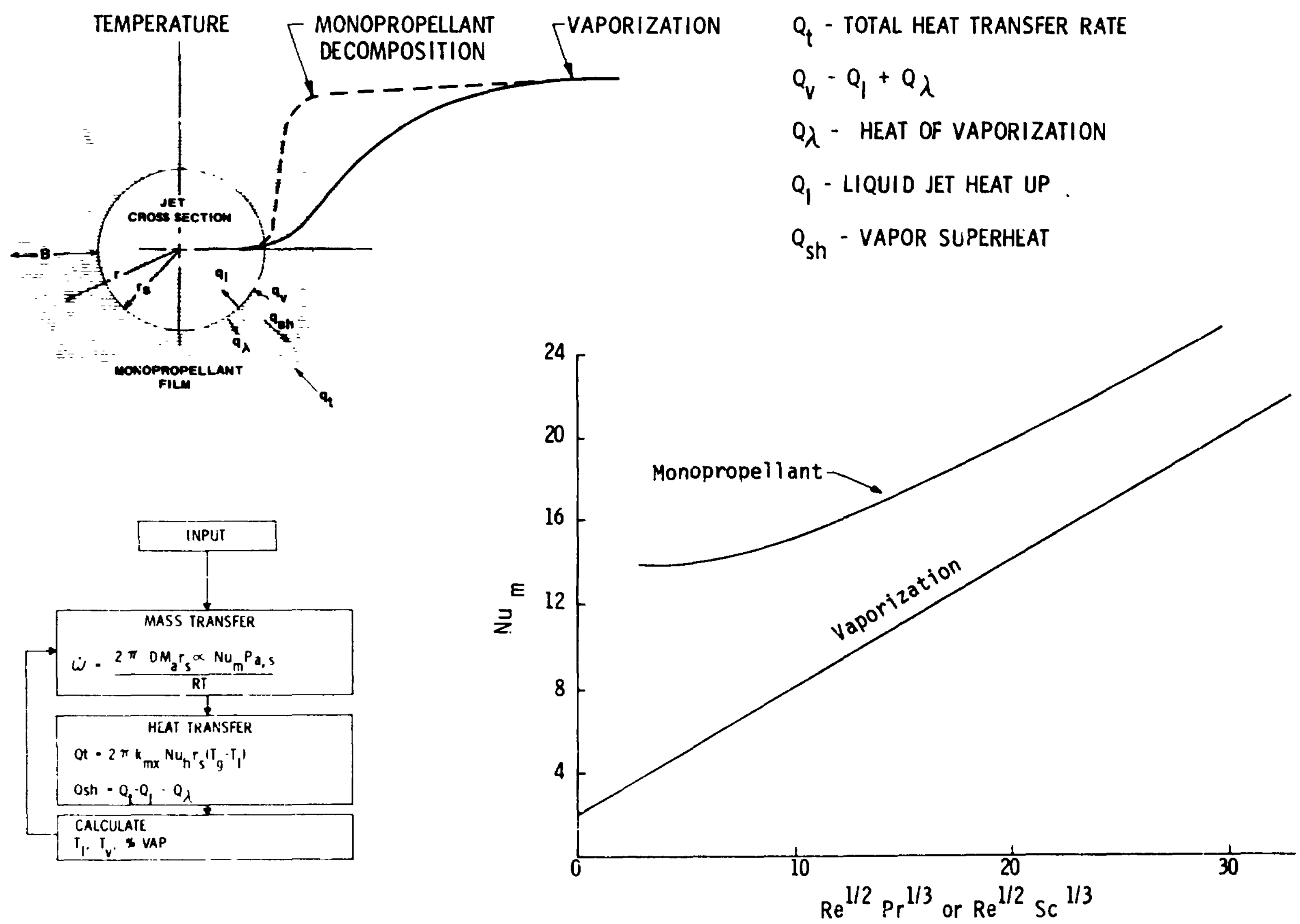


Figure 18. High Pressure RSS Vaporization/Decomposition Model

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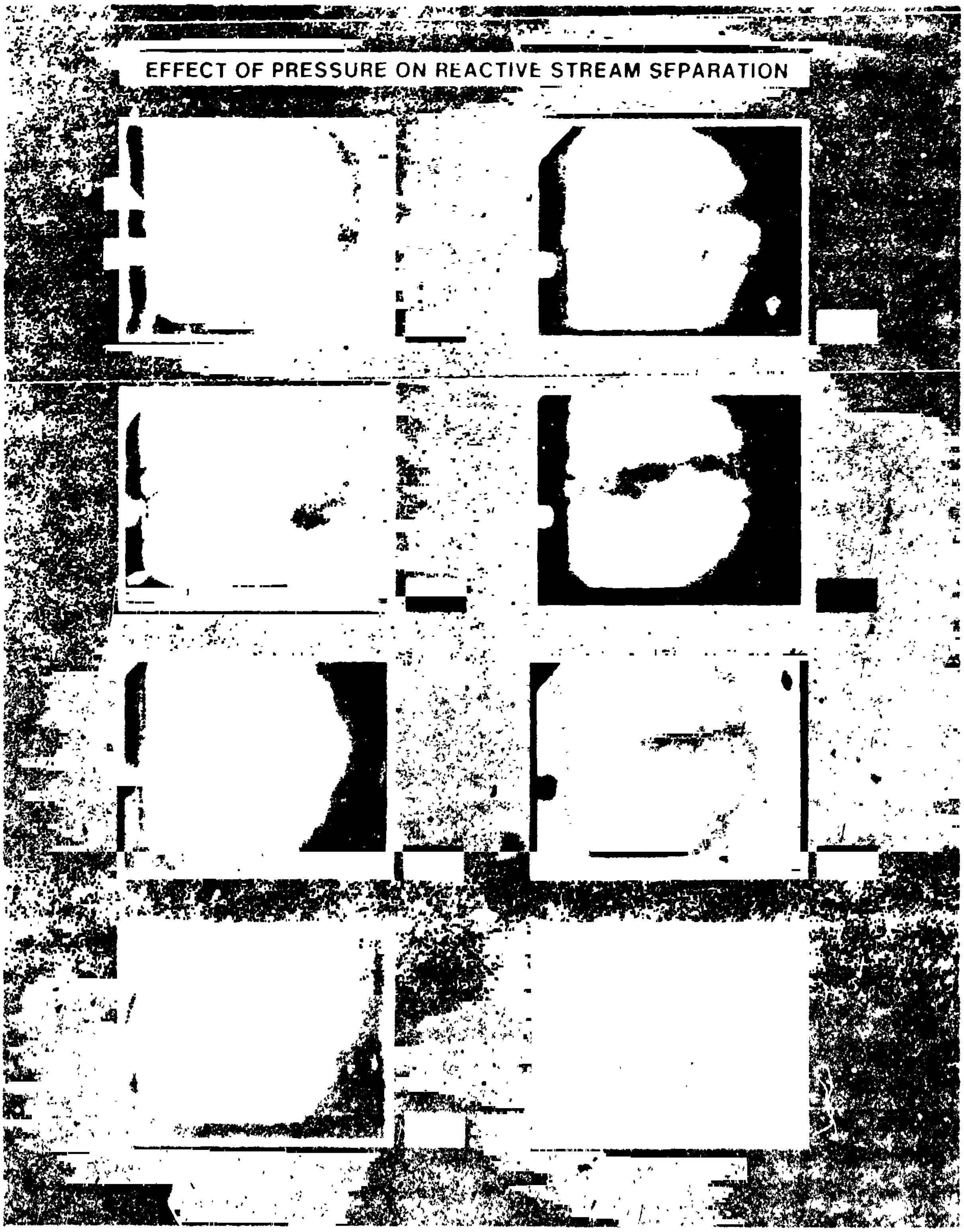

Figure 19. Effect of Pressure on Reactive Stream Separation

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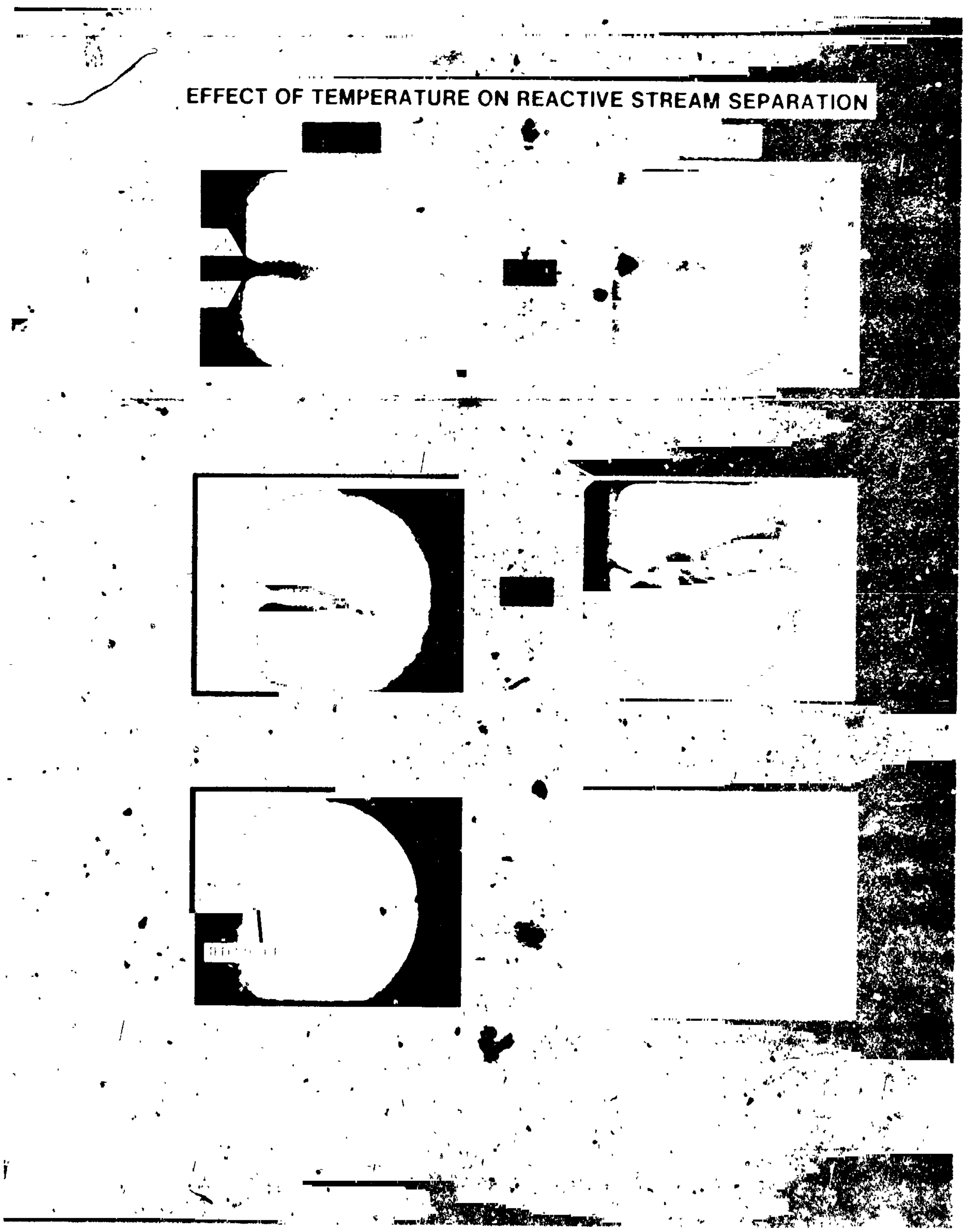


Figure 20. Effect of Temperature on Reactive Stream Separation

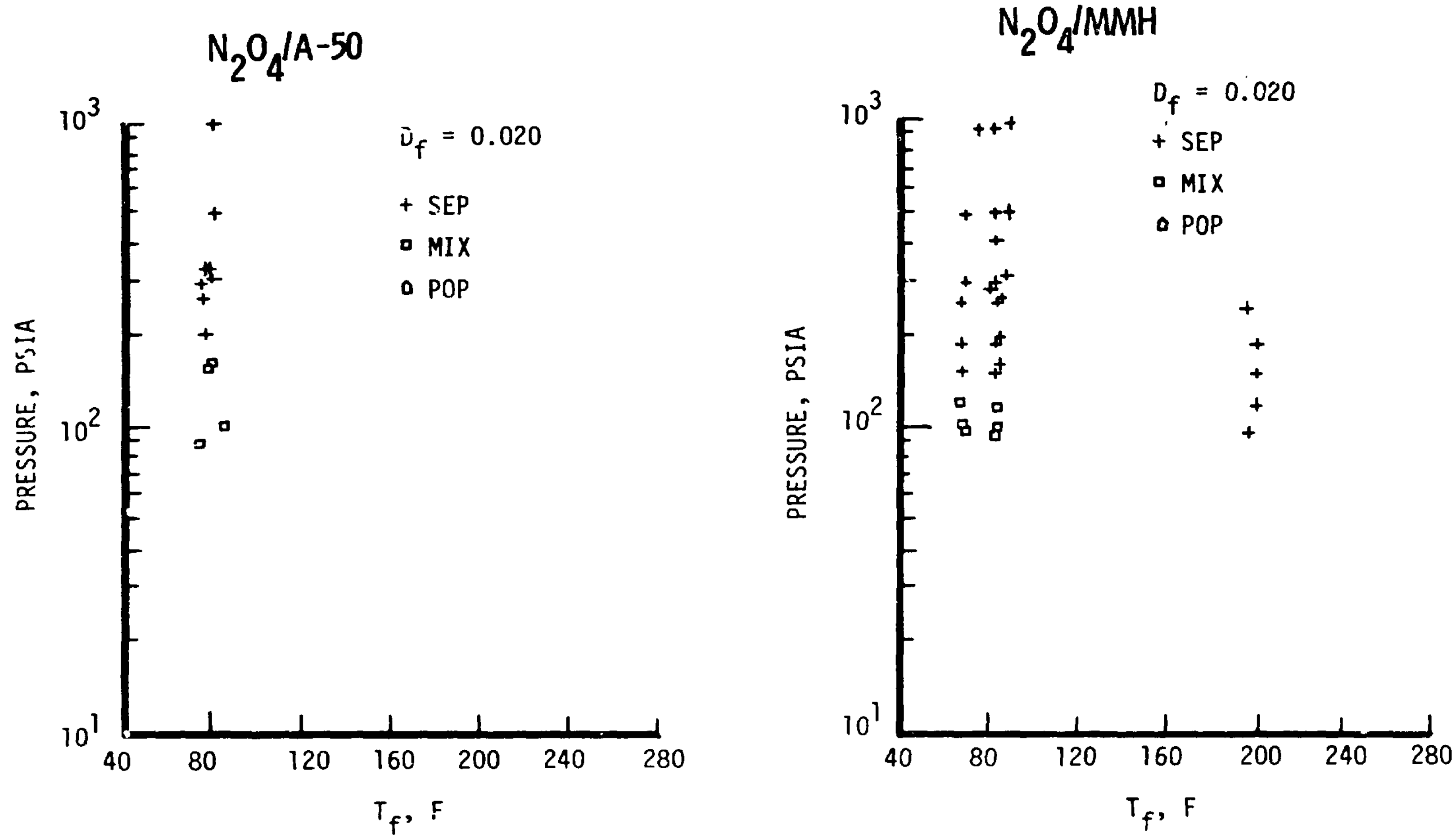


Figure 21. Effect of Pressure and Temperature on RSS

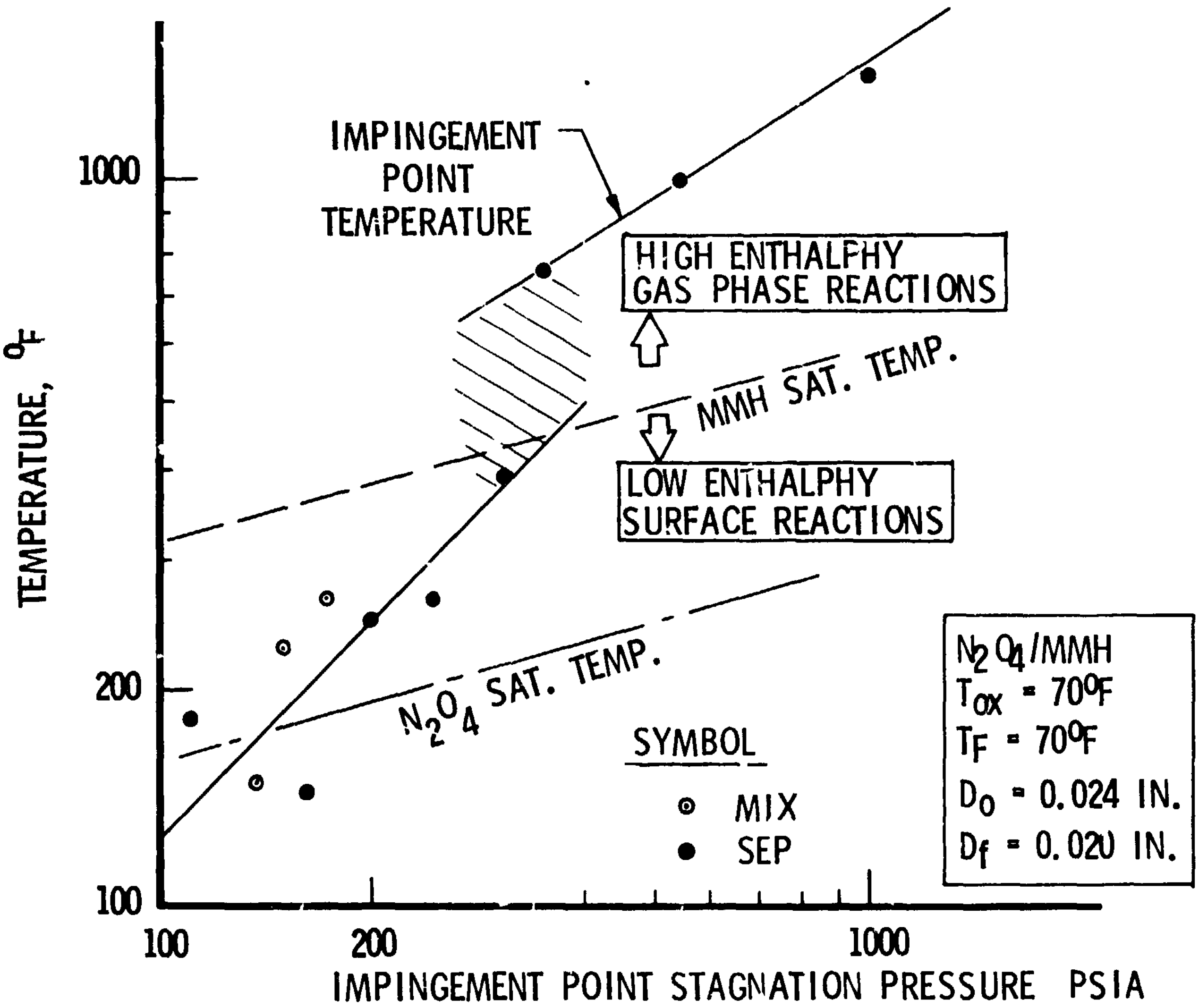


Figure 22. Effect of Pressure on Impingement Point Temperature

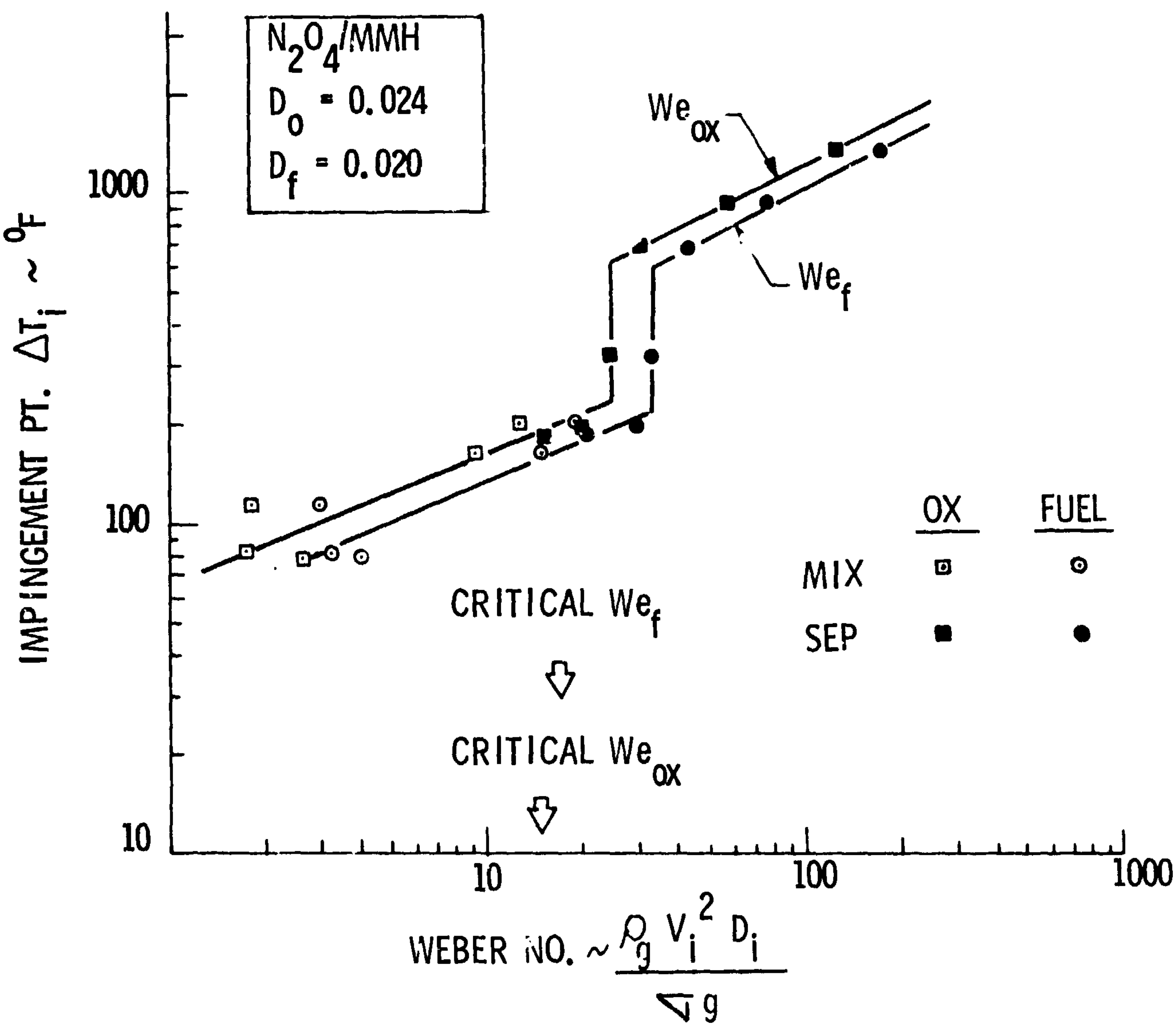


Figure 23. Effect of Weber No. on Impingement Pt. Temperat're Rise

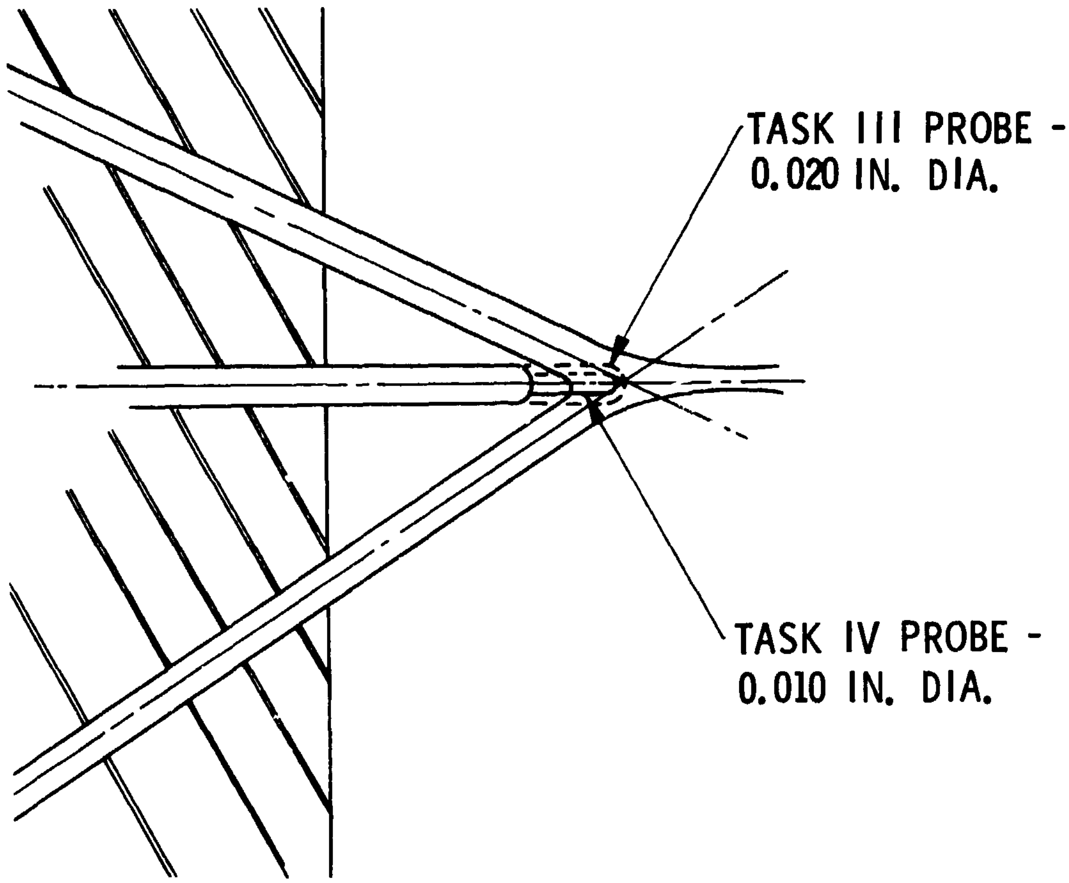


Figure 24. Impingement Point T/C Probe Designs

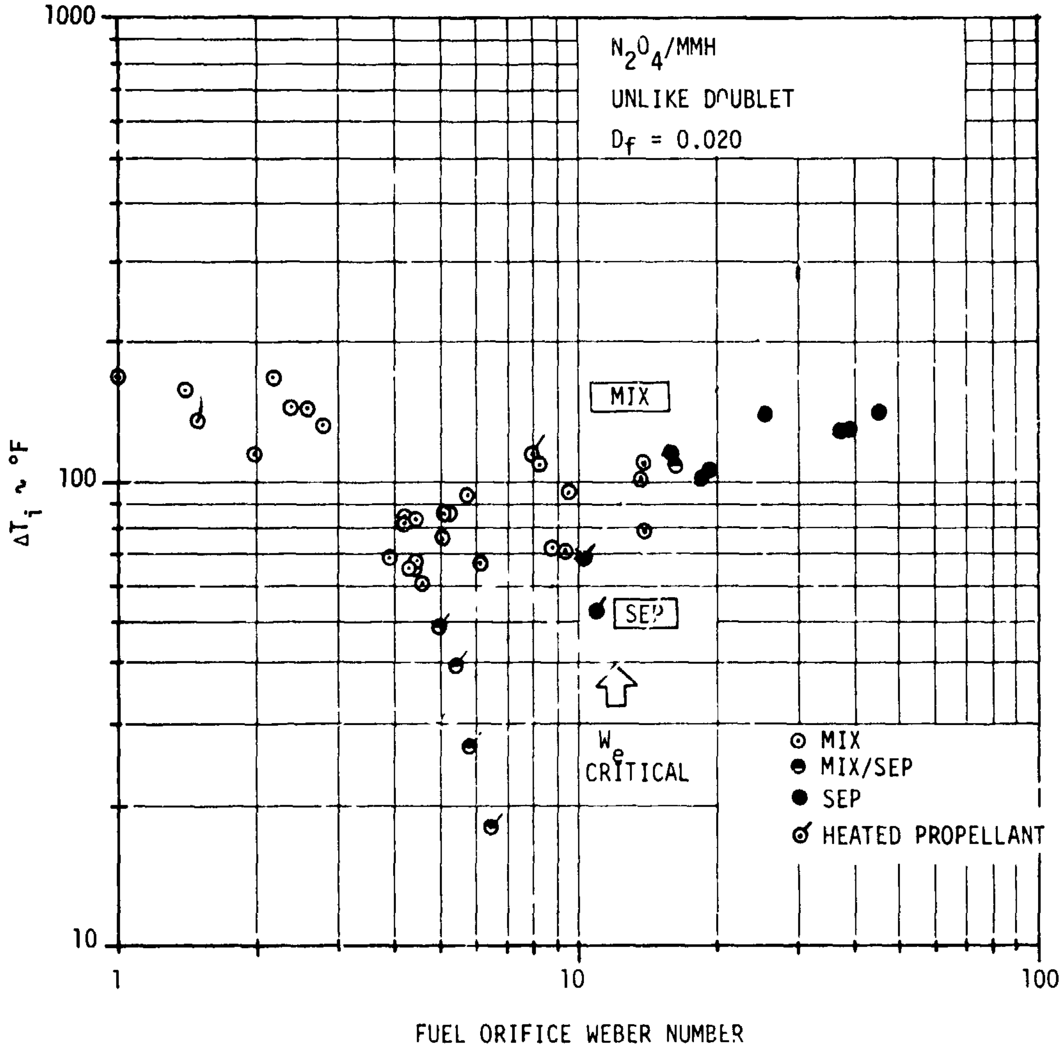


Figure 25. Effect of Fuel Orifice Weber Number on Impingement Point Temperature Rise

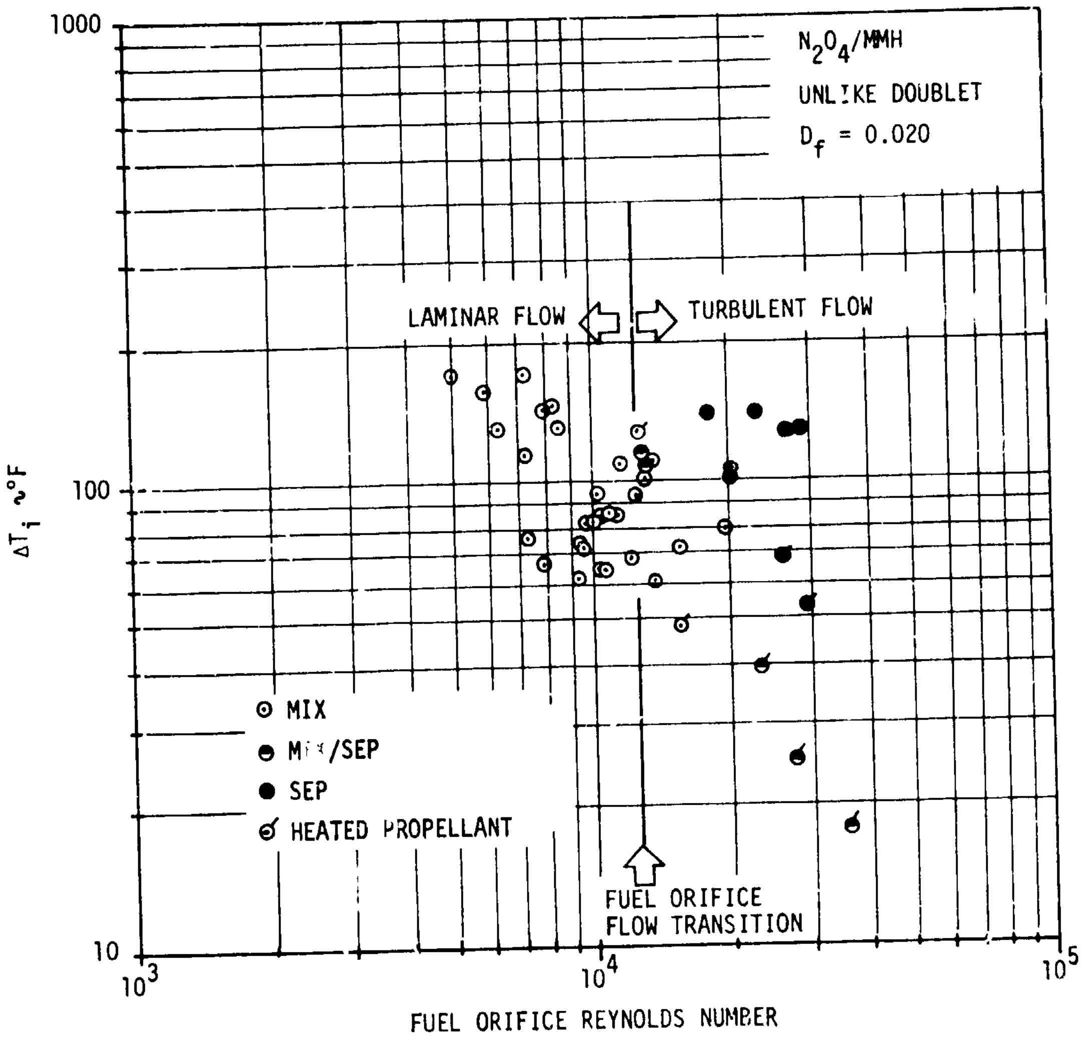


Figure 26. Effect of Fuel Orifice Rynolds Number on Impingment Point Temperature Rise

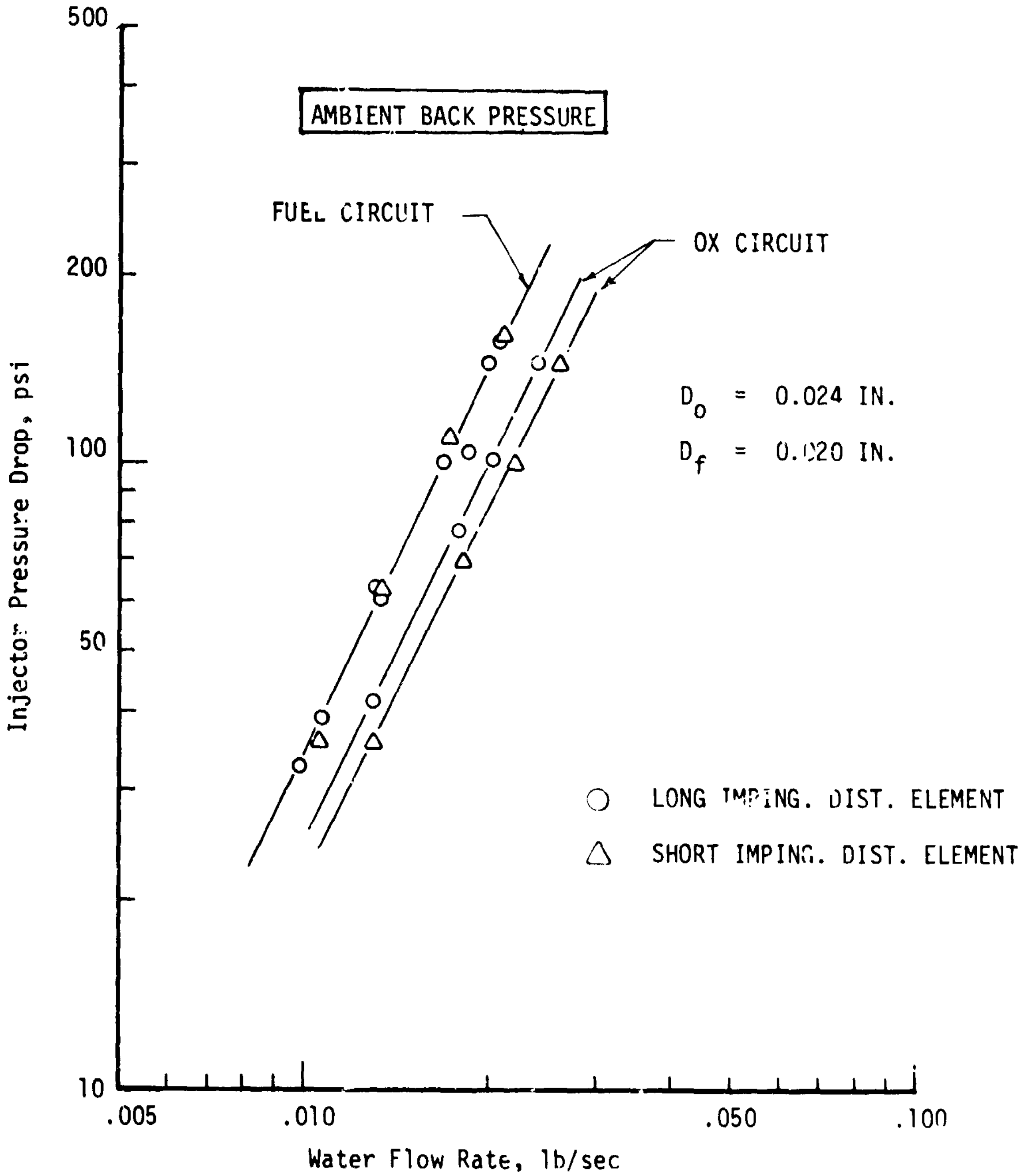


FIGURE 27. PRESSURE DROP CHARACTERISTICS OF UNLIKE DOUBLET INJECTOR ELEMENTS

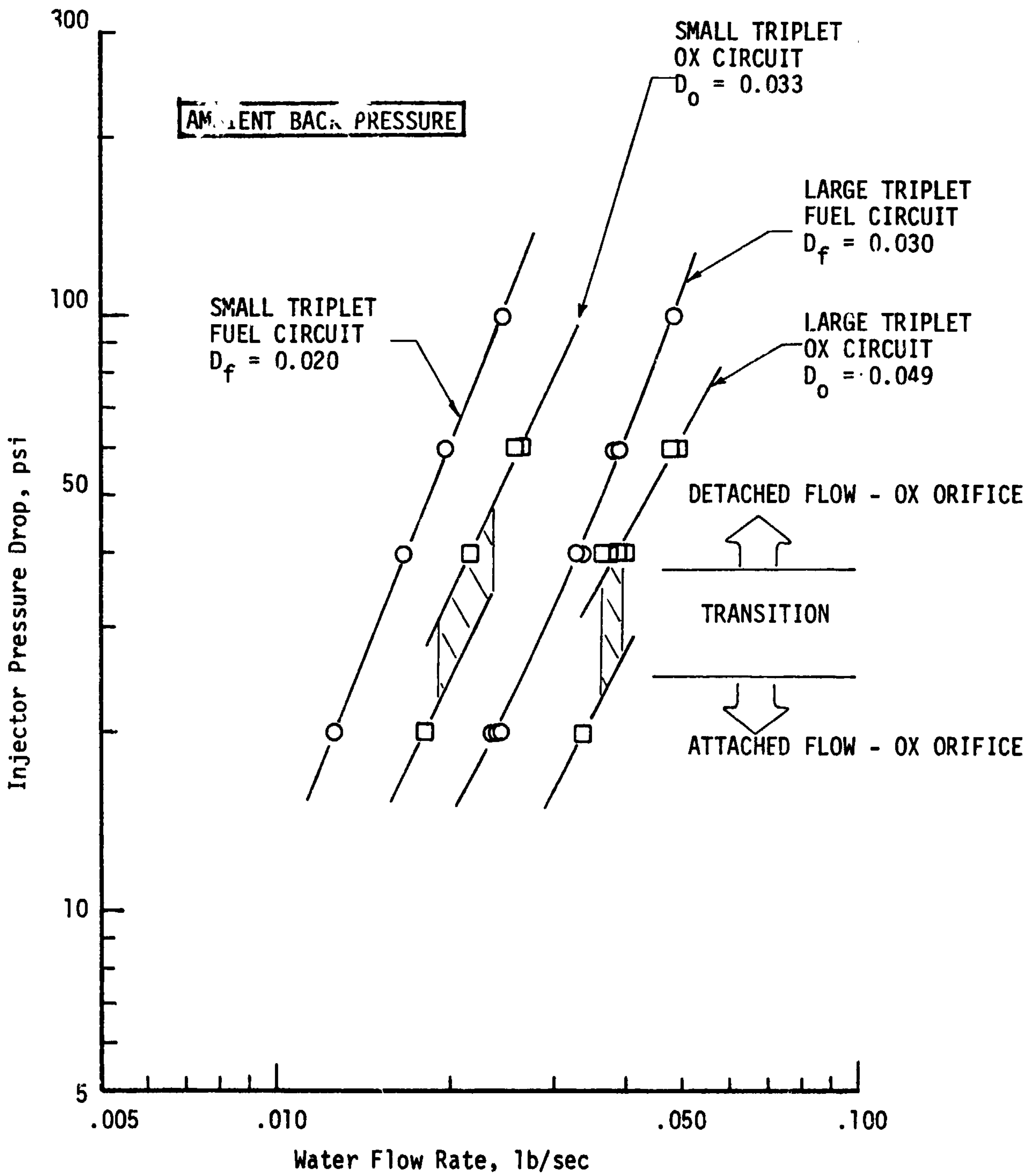


FIGURE 28. PRESSURE DROP CHARACTERISTICS OF TRIPLET INJECTOR ELEMENTS

C-2

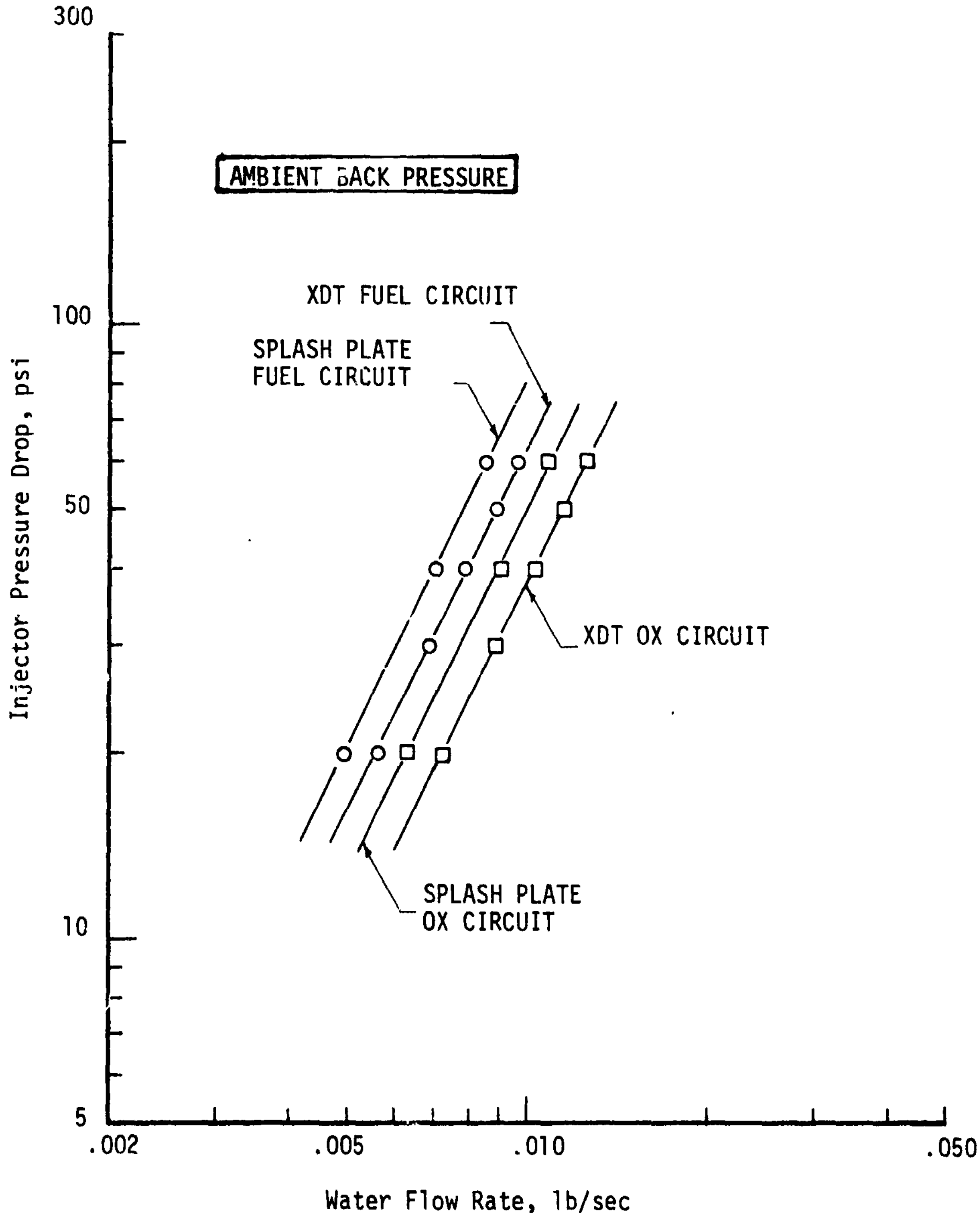


FIGURE 29. PRESSURE DROP CHARACTERISTICS OF PLATELET ELEMENT

UNLIKE DOUBLET HYDRAULIC CHARACTERISTICS

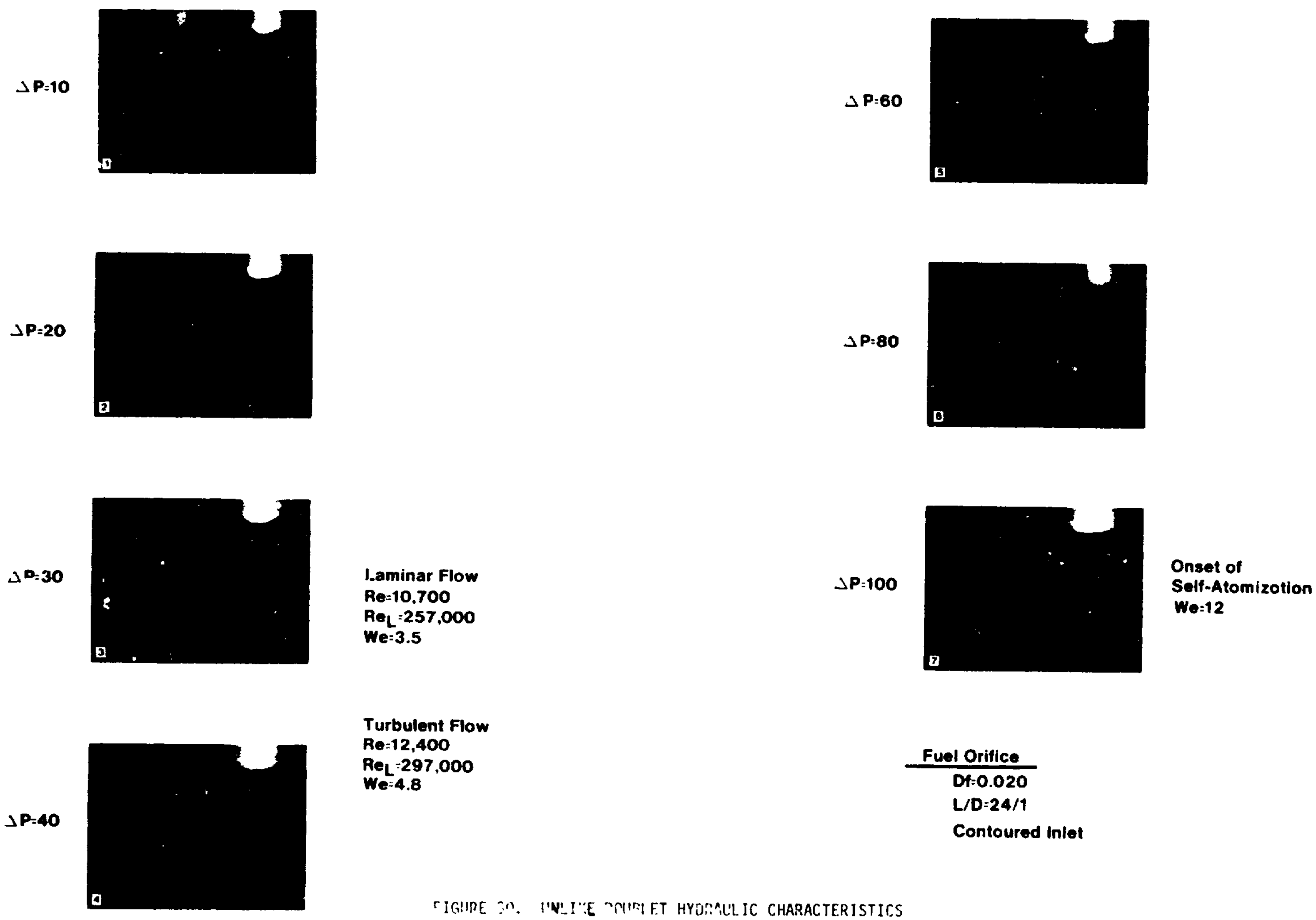


FIGURE 30. UNLIKE DOUBLET HYDRAULIC CHARACTERISTICS

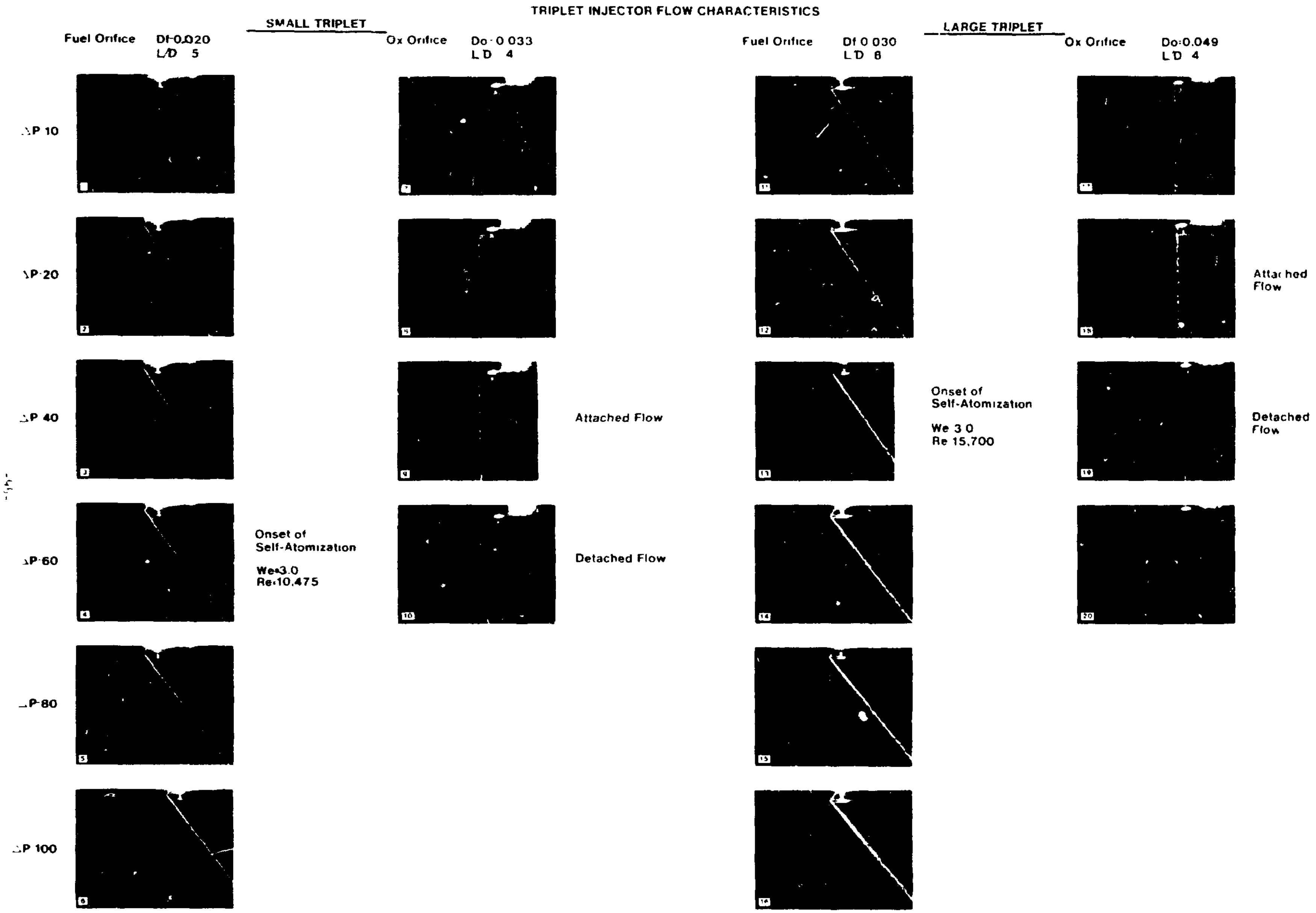


FIGURE 31 TRIPLET INJECTOR FLOW CHARACTERISTICS

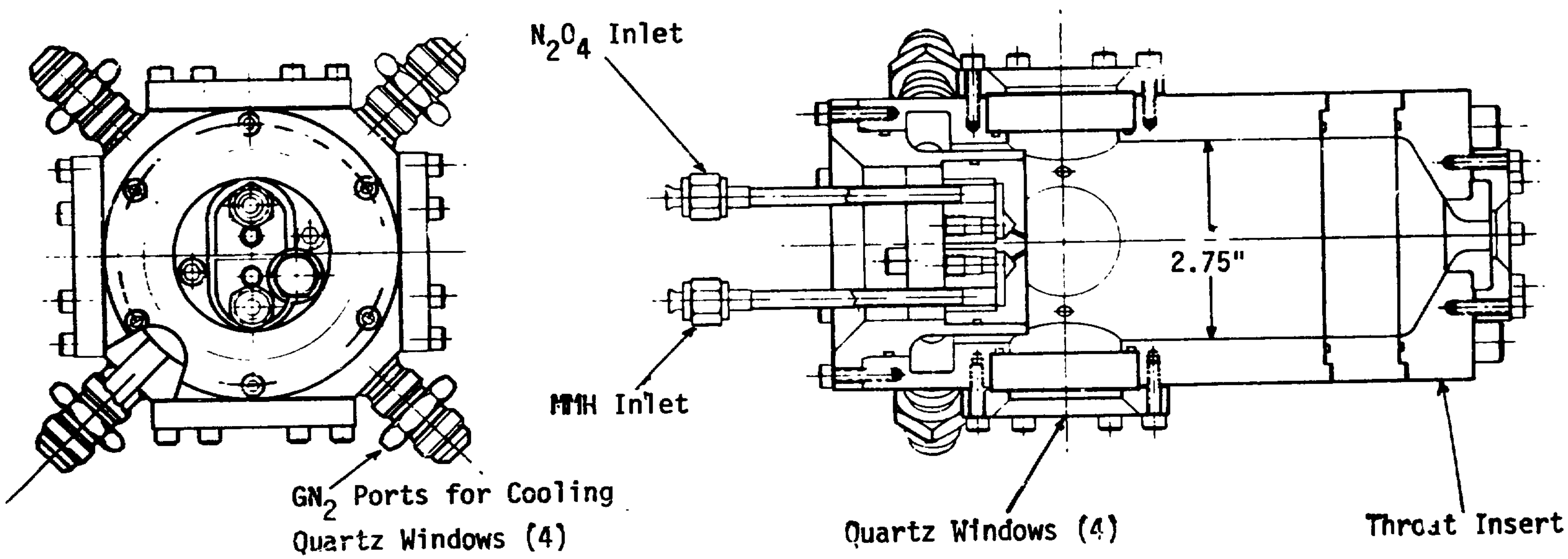
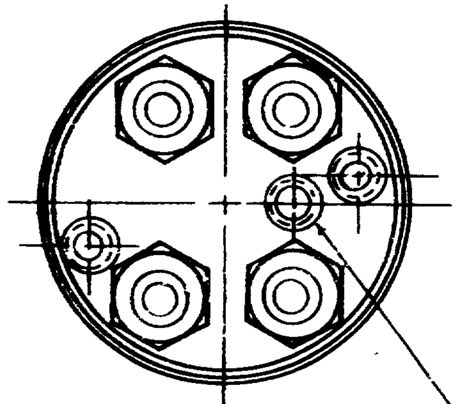
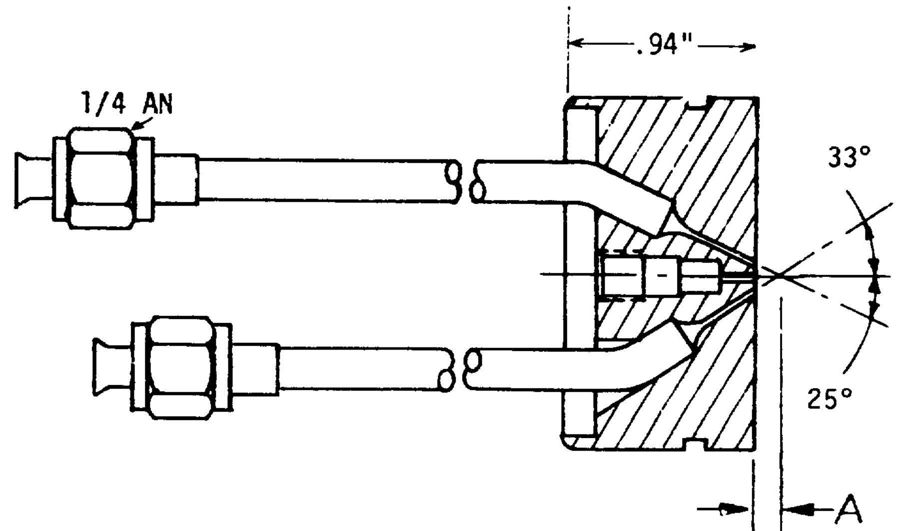


Figure 32. Windcwed Photographic Test Chamber





Contoured Inlet

STA	D_f	D_o	A	L/D_f	L/D_o
1	0.020	0.024	0.160	24.0	23.5
2	0.020	0.024	0.060	24.0	23.5

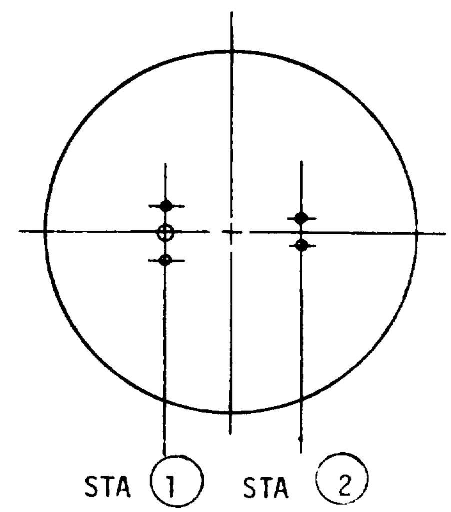
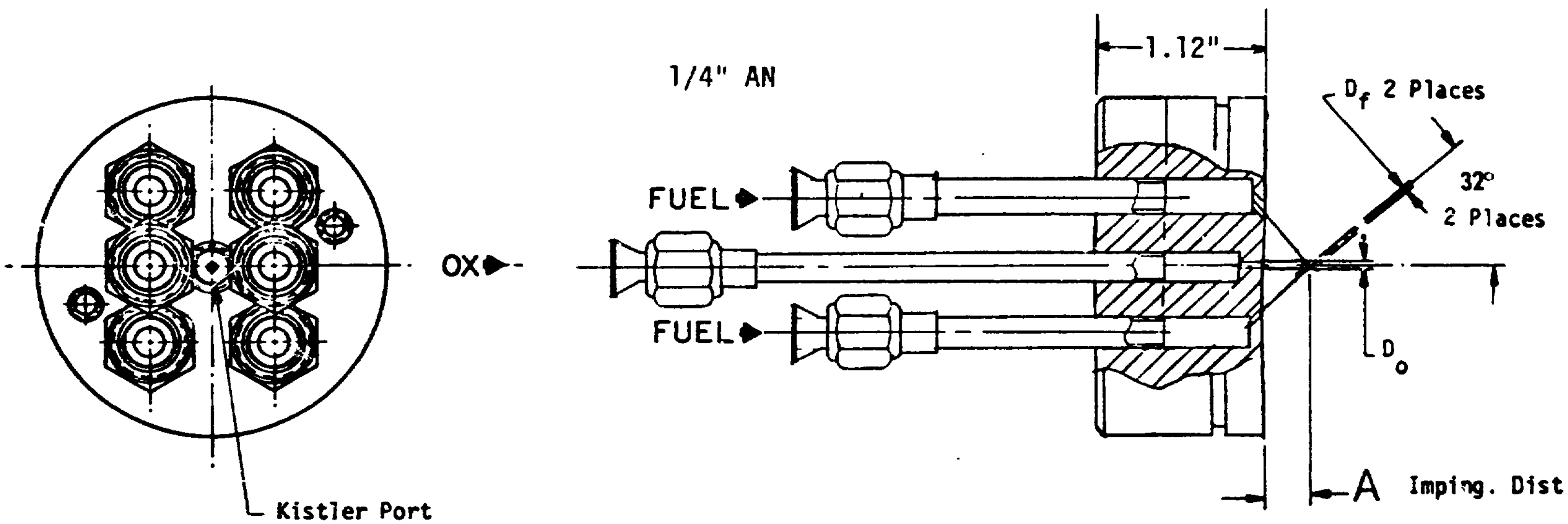


Figure 33. Unlike Doublet Injector



STA.	D_f	D_o	A	L/D_f	L/D_o
1	0.030	0.049	0.400	6.0	4.1
2	0.020	0.033	0.400	5.3	4.0

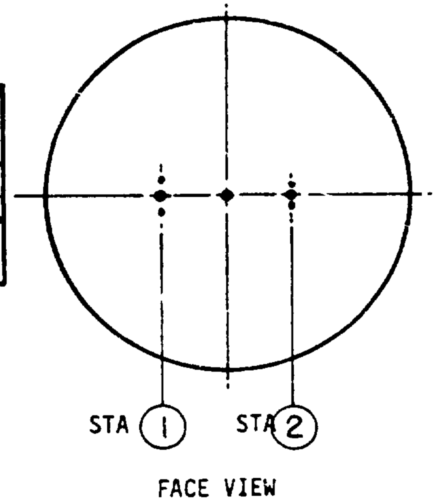


Figure 34. Triplet Injector

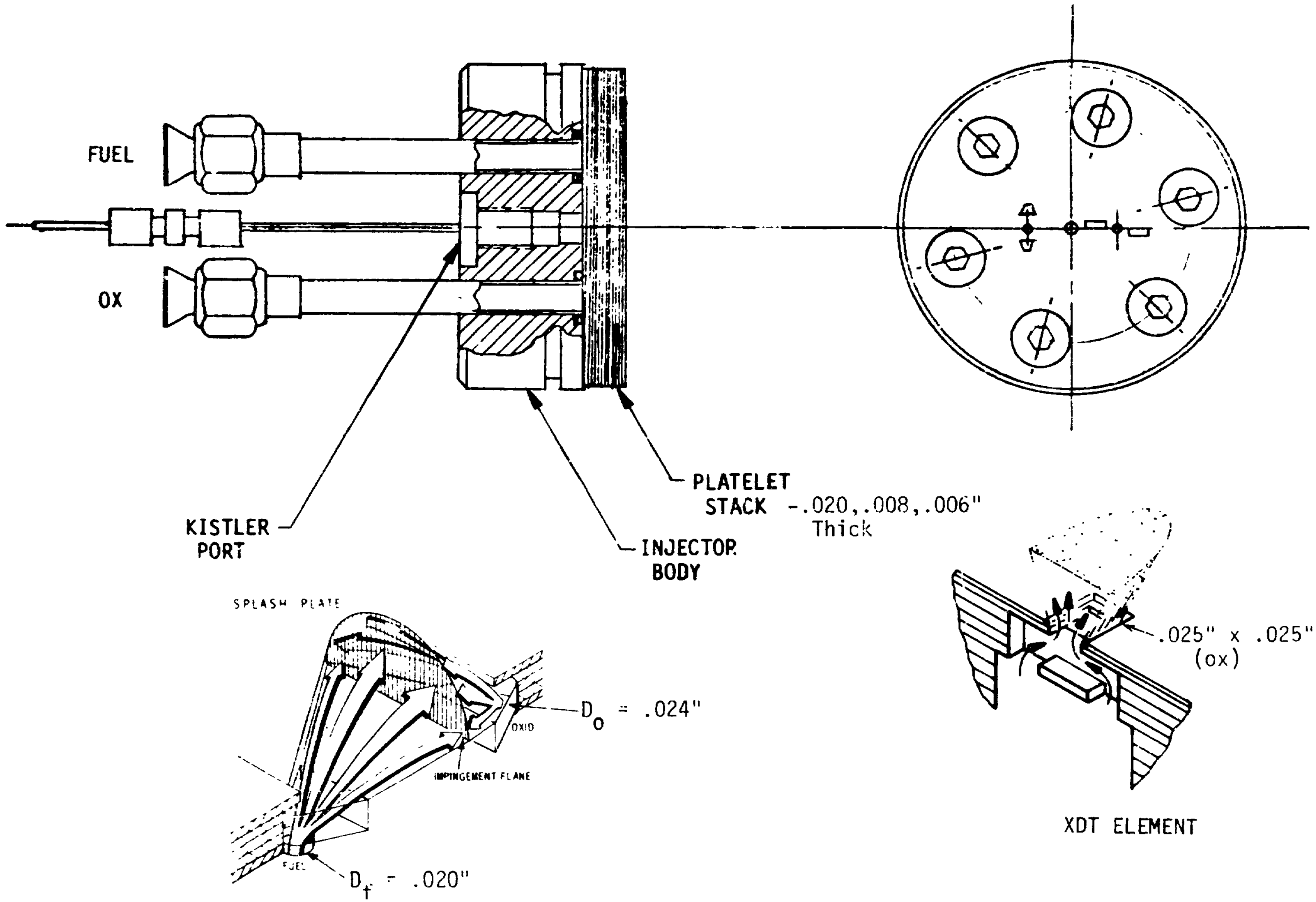


Figure 35. Self-Atomizing Platelet Injector Elements

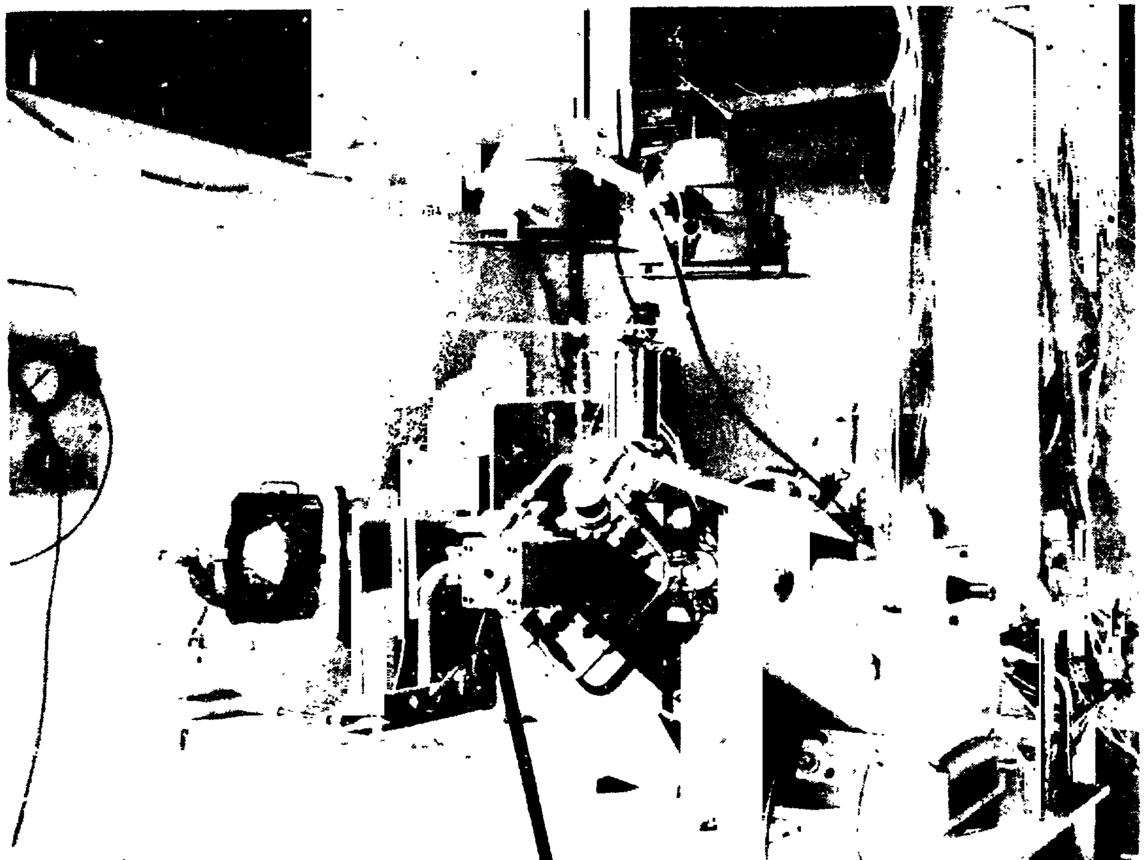


Figure 36. Photographic Test Setup

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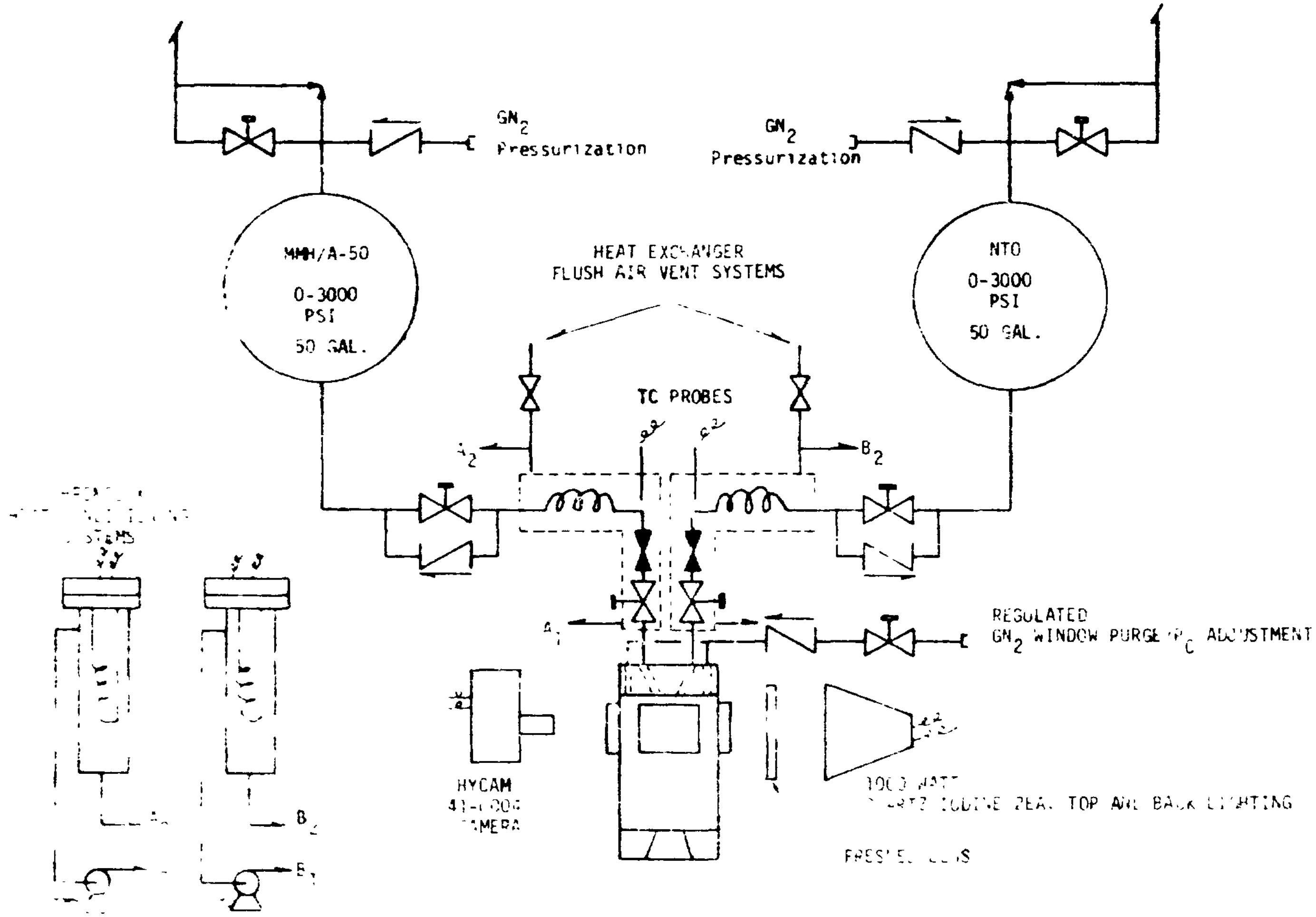

Figure 37. Propellant Flow System Schematic

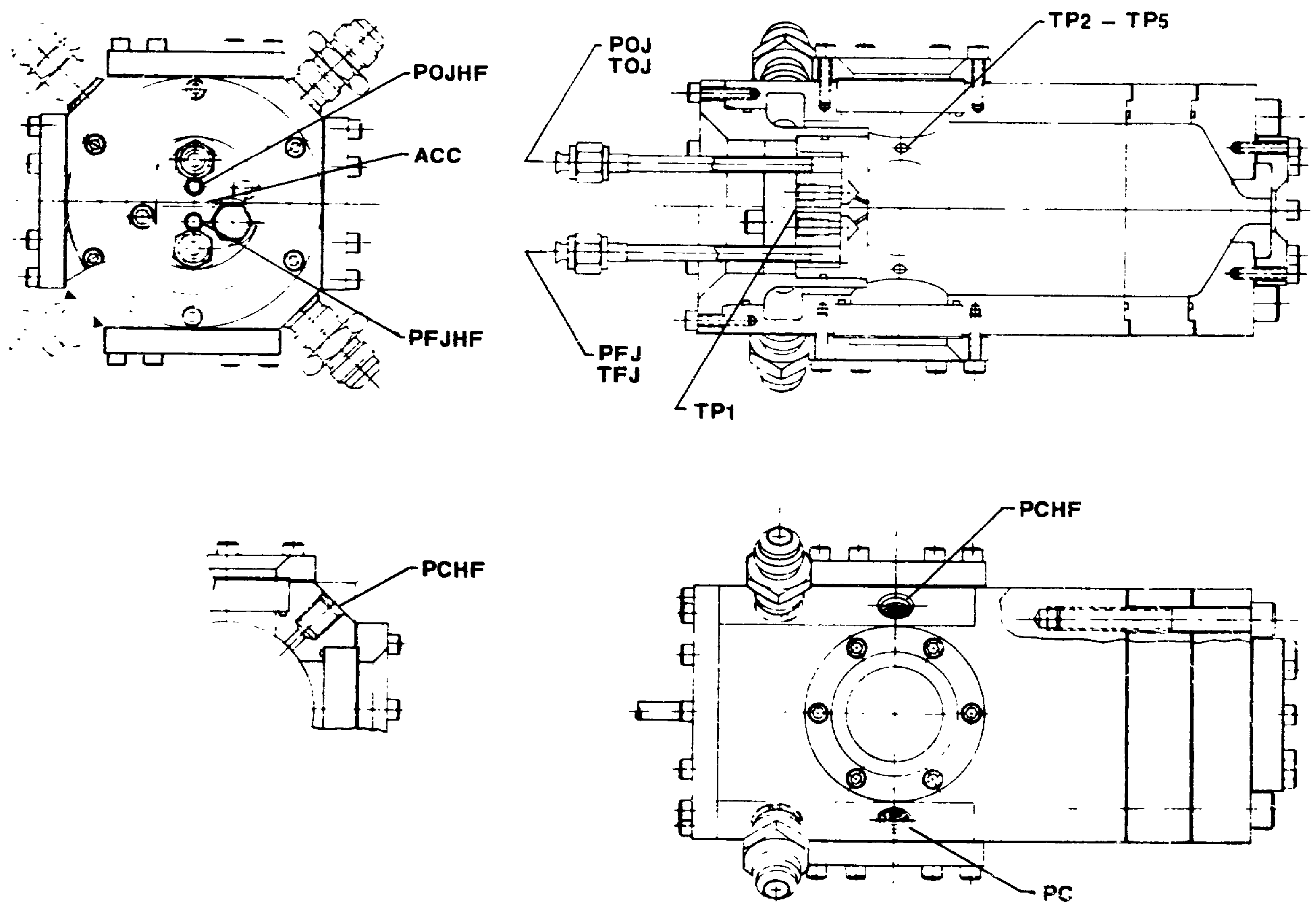

Figure 38. Instrumentation Schematic

APPENDIX A

NOMENCLATURE

NOMENCLATURE

a	Coefficient in power form separation pressure correlation
b	Exponent in power form separation pressure correlation
C	Reactant concentration
C_p	Heat capacity
d	Orifice diameter
D	Orifice spacing parameter
DELT1	Impingement point temperature rise
EM	Rupe mixing parameter
g	Gravitational constant
IS	ln (D/V sin 1/2 imp. angle) + 46.8 - 21800 (1/T)
K	Rate constant
L	Orifice length
M	Mass
m	Concentration exponent, propellant 1
MR	Mixture ratio oxidizer/fuel
MW	Molecular weight
n	Concentration exponent, propellant 2
P	Pressure
PD	Pc/D
ΔP	Pressure difference
PPF	Fuel partial pressure
PPO	Oxidizer partial pressure
$\dot{Q}$	Liquid phase heat release
R	Reactivity, gas constant, or element spacing coefficient
RE	Orifice Reynolds number based on diameter
REL	Orifice Reynolds number based on length
RESID	Propellant stream contact time
S	Element spacing

Nomenclature (cont.)

SPR	Fuel to oxidizer momentum flux ratio
T	Temperature
ΔT	Temperature difference
t	Time
tr	D/V, propellant stream contact time
V	Velocity or volume
W_e	Weber Number
$\dot{W}$	Weight flow rate
X	Mole fraction
XP	Square root of fuel and oxidizer mole fraction product

Greek

μ	Viscosity
ρ	Density
τ	Time
σ	Surface tension

Subscripts

a	Ambient conditions
Avg	Average conditions
c	Chamber conditions
f	fuel
g	Gas phase
i	Impingement point condition
ing	Ignition
J	Manifold value
L	Liquid
LIG	Ligament

Nomenclature (cont.)

ox	Oxidizer
p	Partial pressure
RES	Stream residence (contact)
RSS	Separated conditions
V	Vapor
VP	Vapor phase

APPENDIX B

FINAL DATA CORRELATIONS

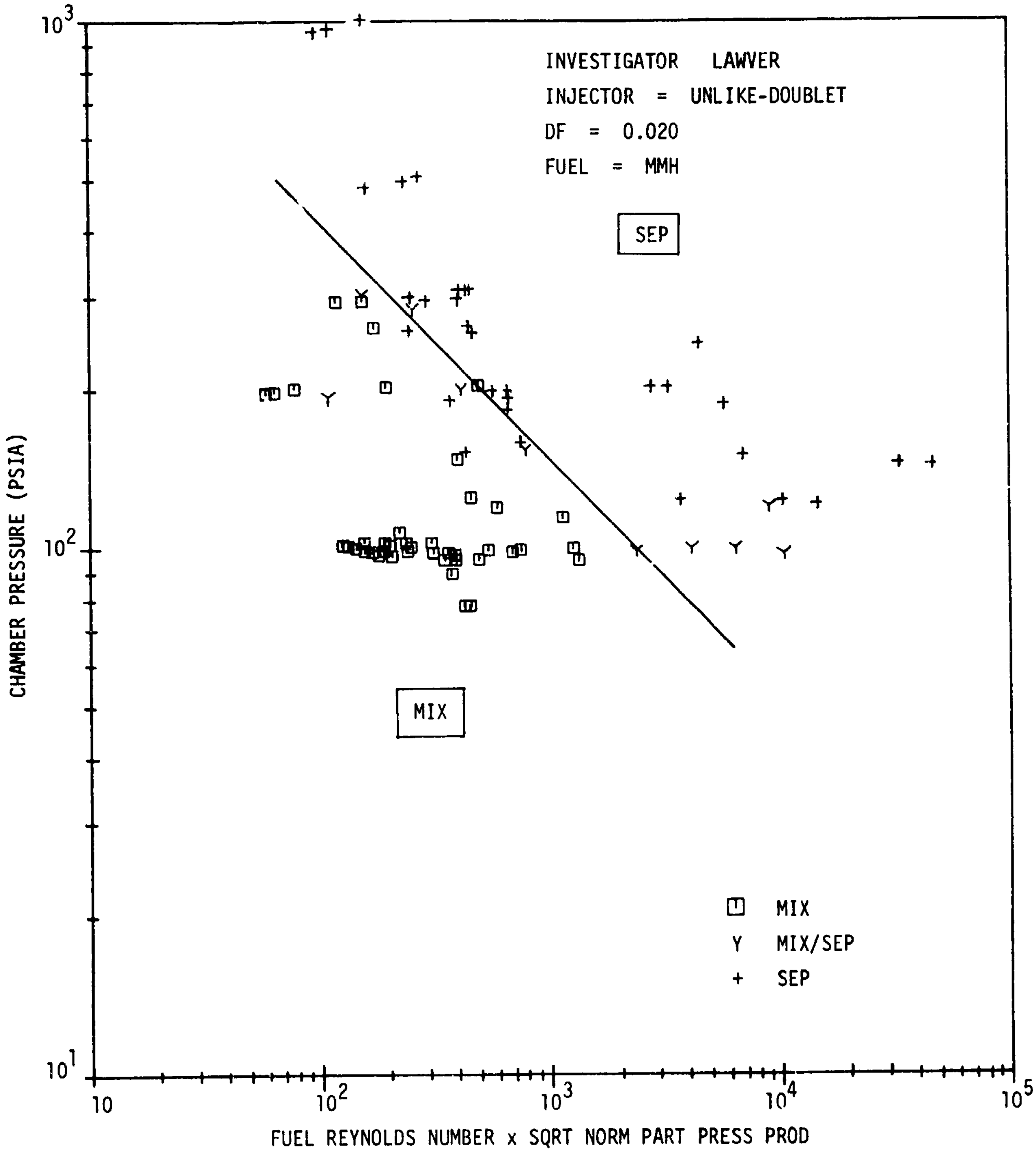

Figure B-1.Effect of Chamber Pressure and Reactivity on RSS

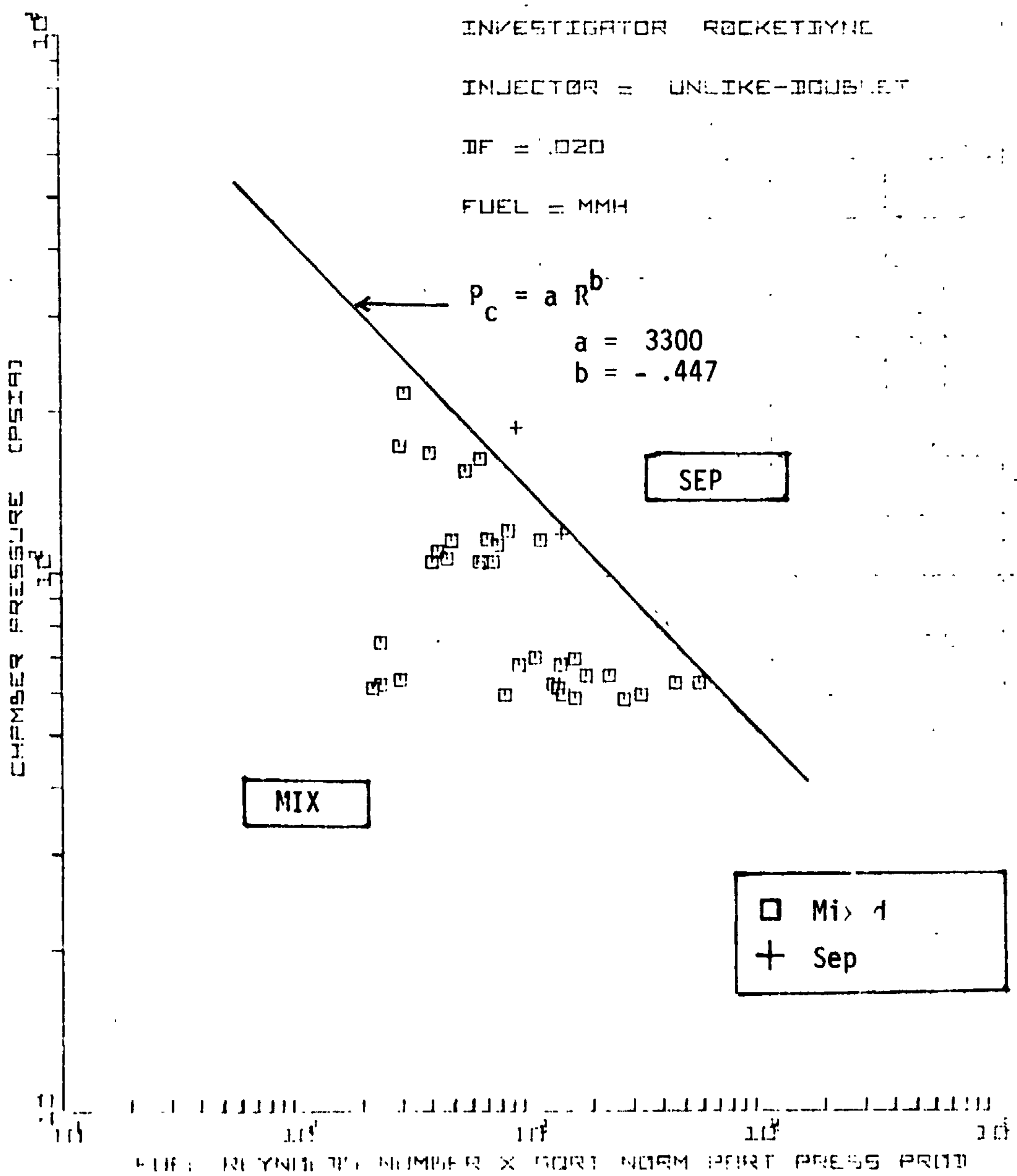

Figure B-2. Rocketdyne Unlike-Doublet, D_f = .020

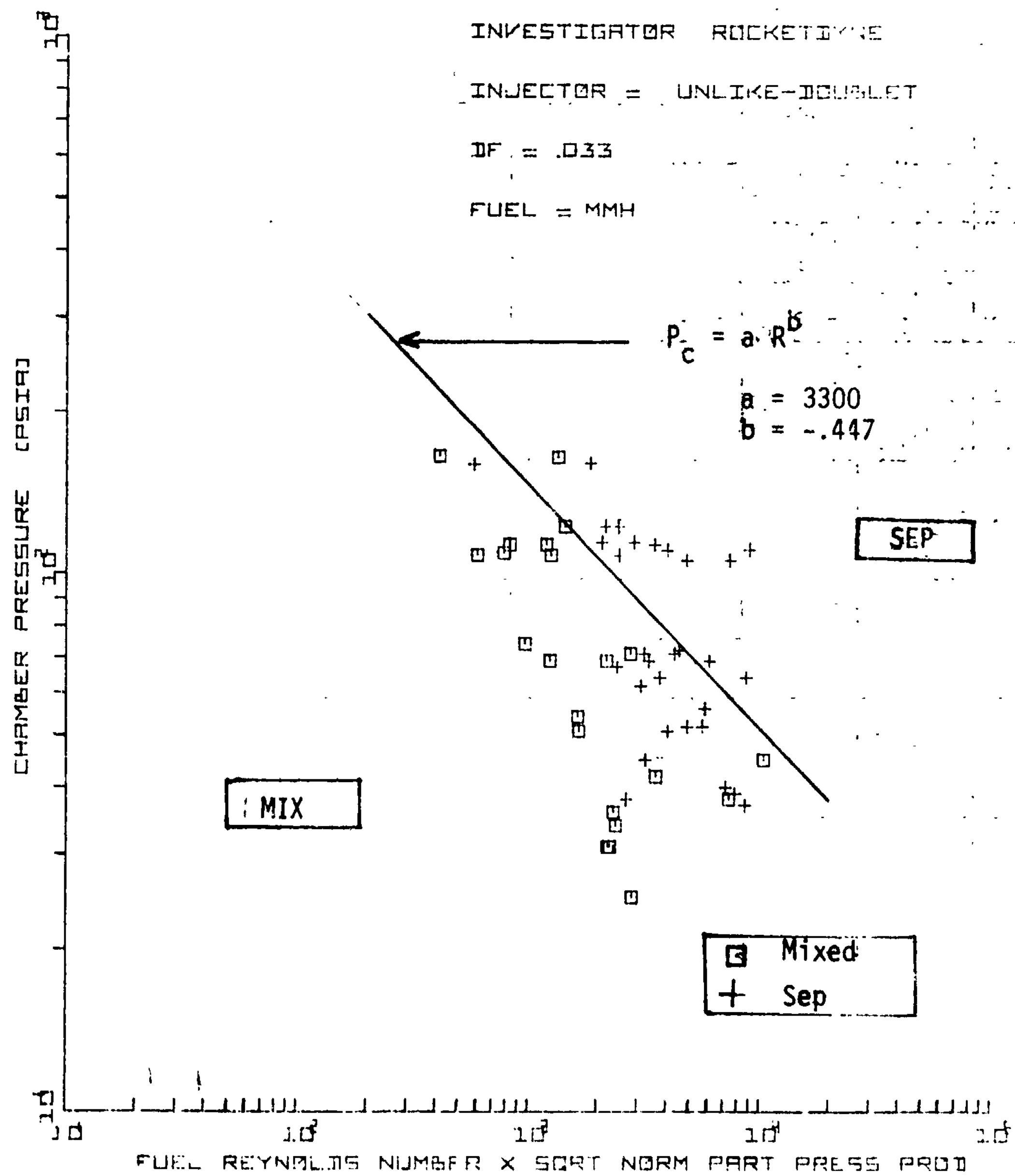

Figure B-3. Rocketdyne Unlike-Doublet, D_f = .033

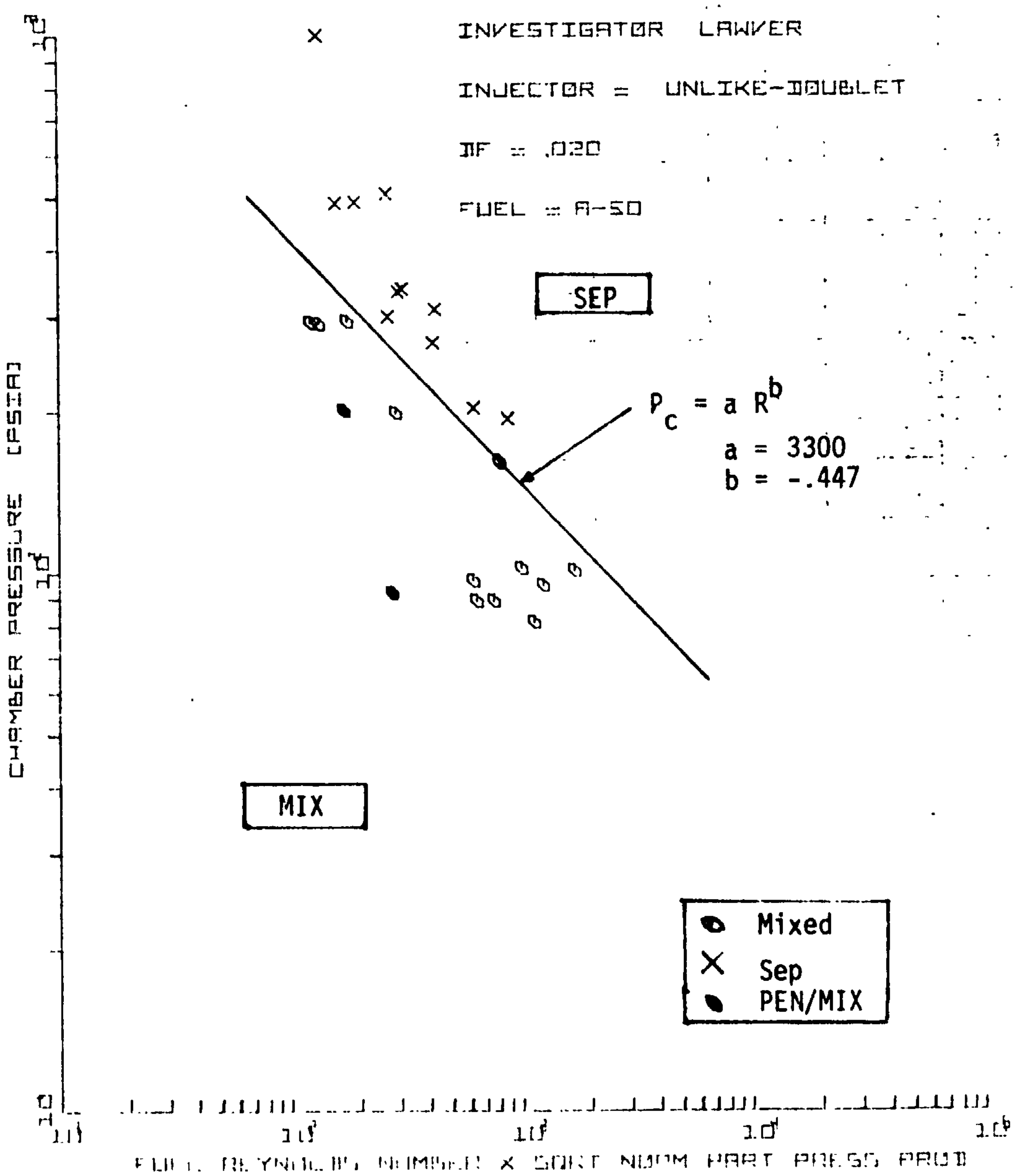

Figure B-4. Lawver Unlike Doublet, D_f = .020

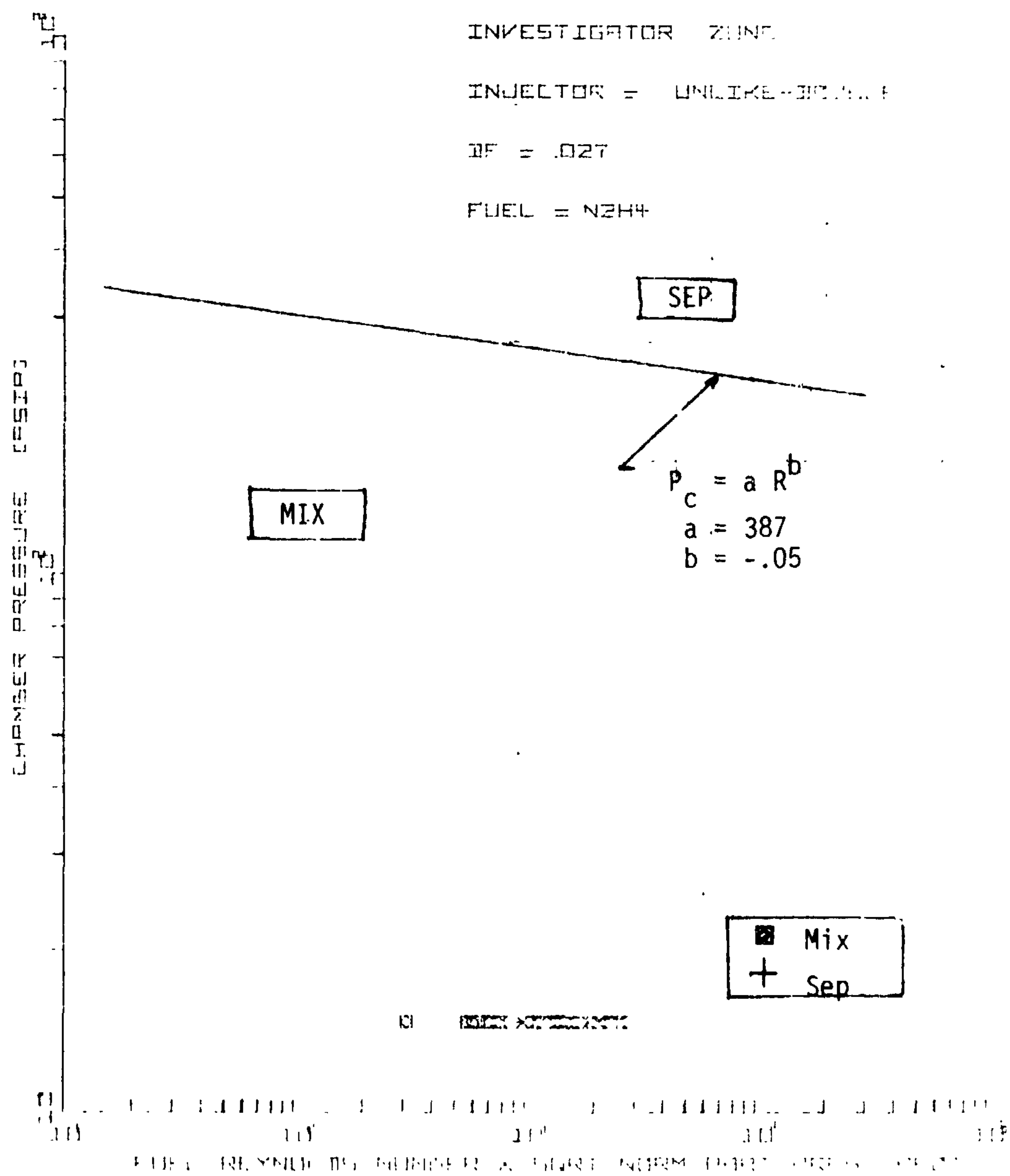

Figure B-5. Zung Unlike-Doublet, D_f = .027

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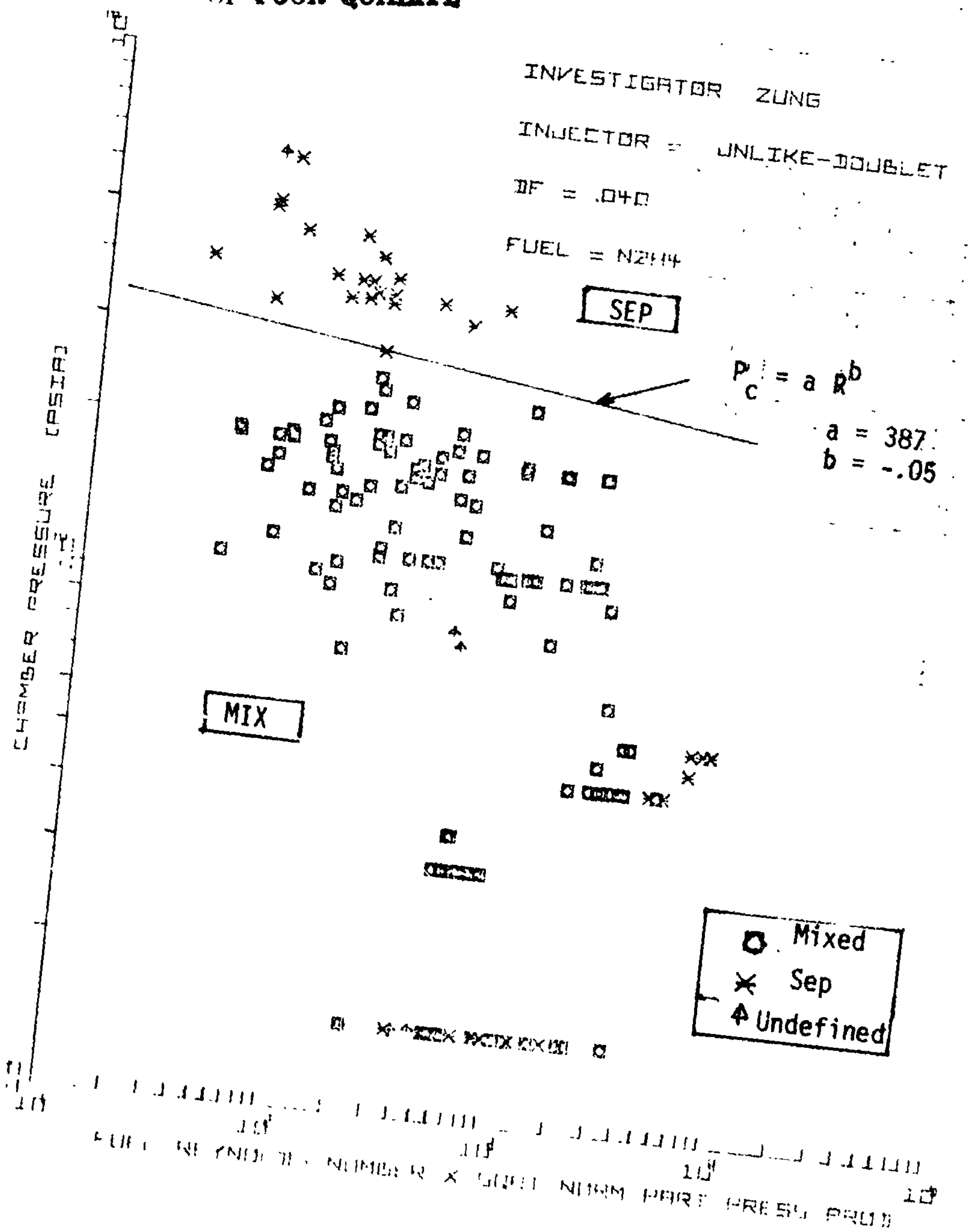

Figure B-6. Zung Unlike-Doublet, D_f = .040

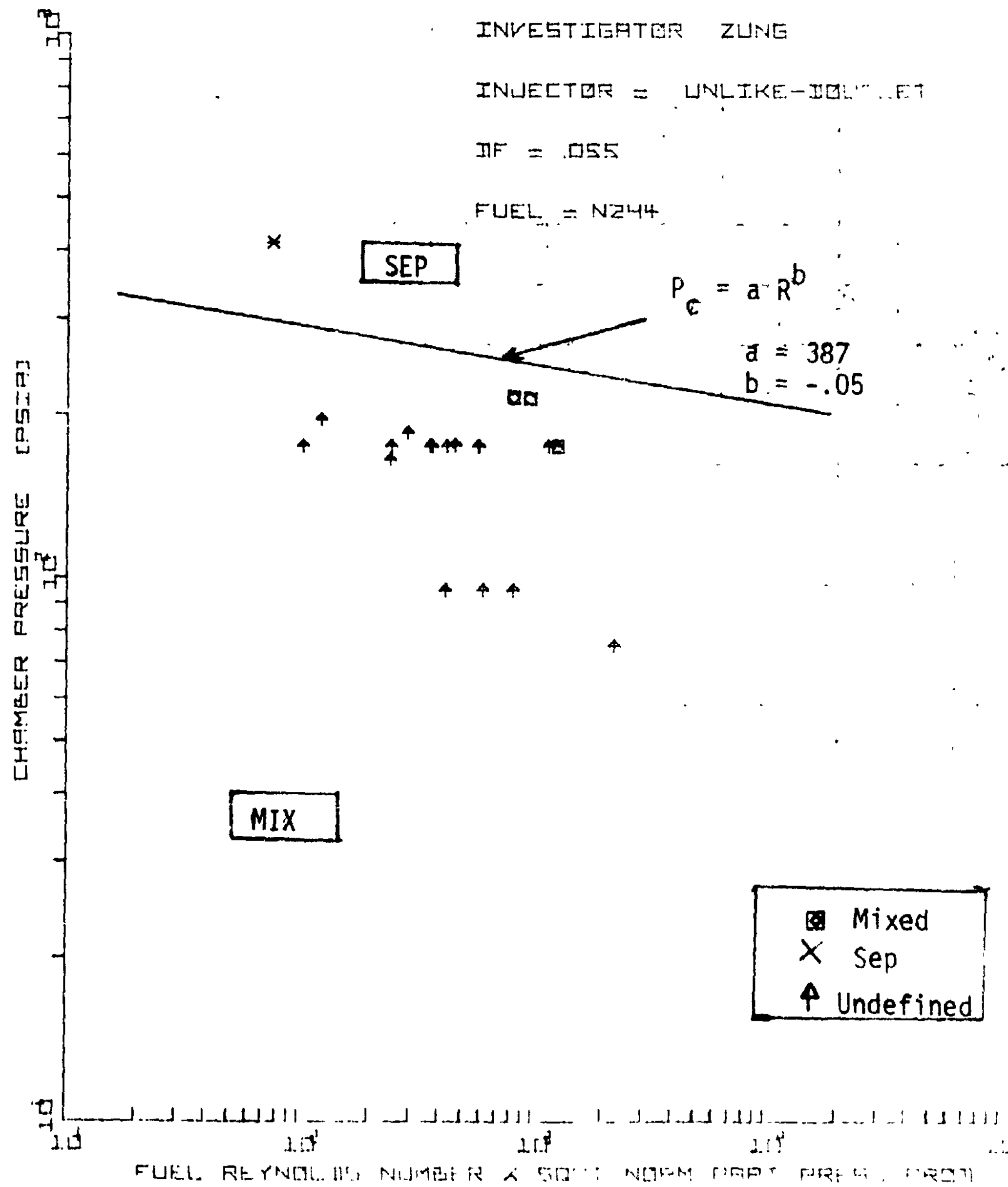

Figure B-7. Zung Unlike-Doublet, D_f = .055

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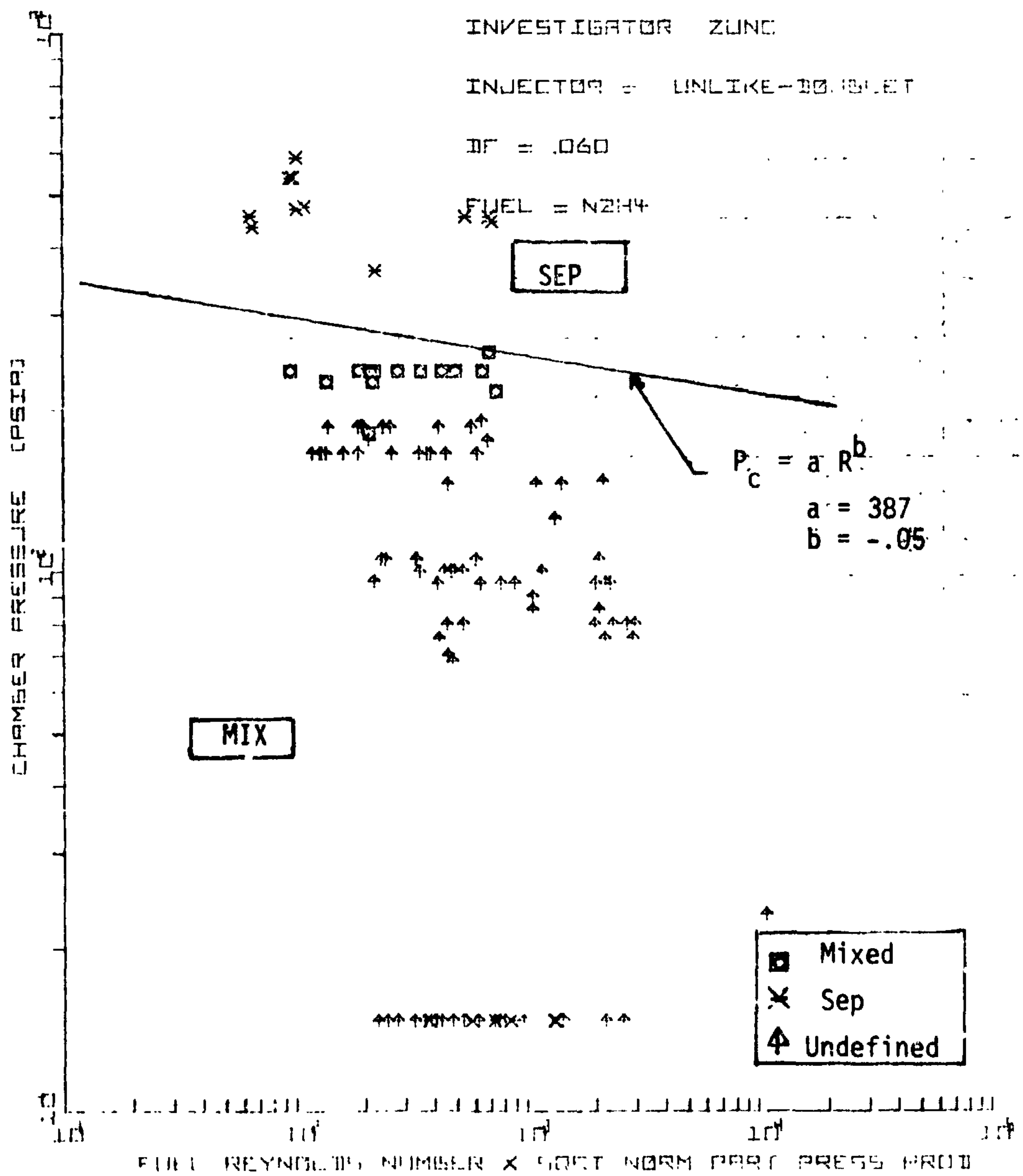

Figure B-8. Zung Unlike-Doublet, D_f = .060

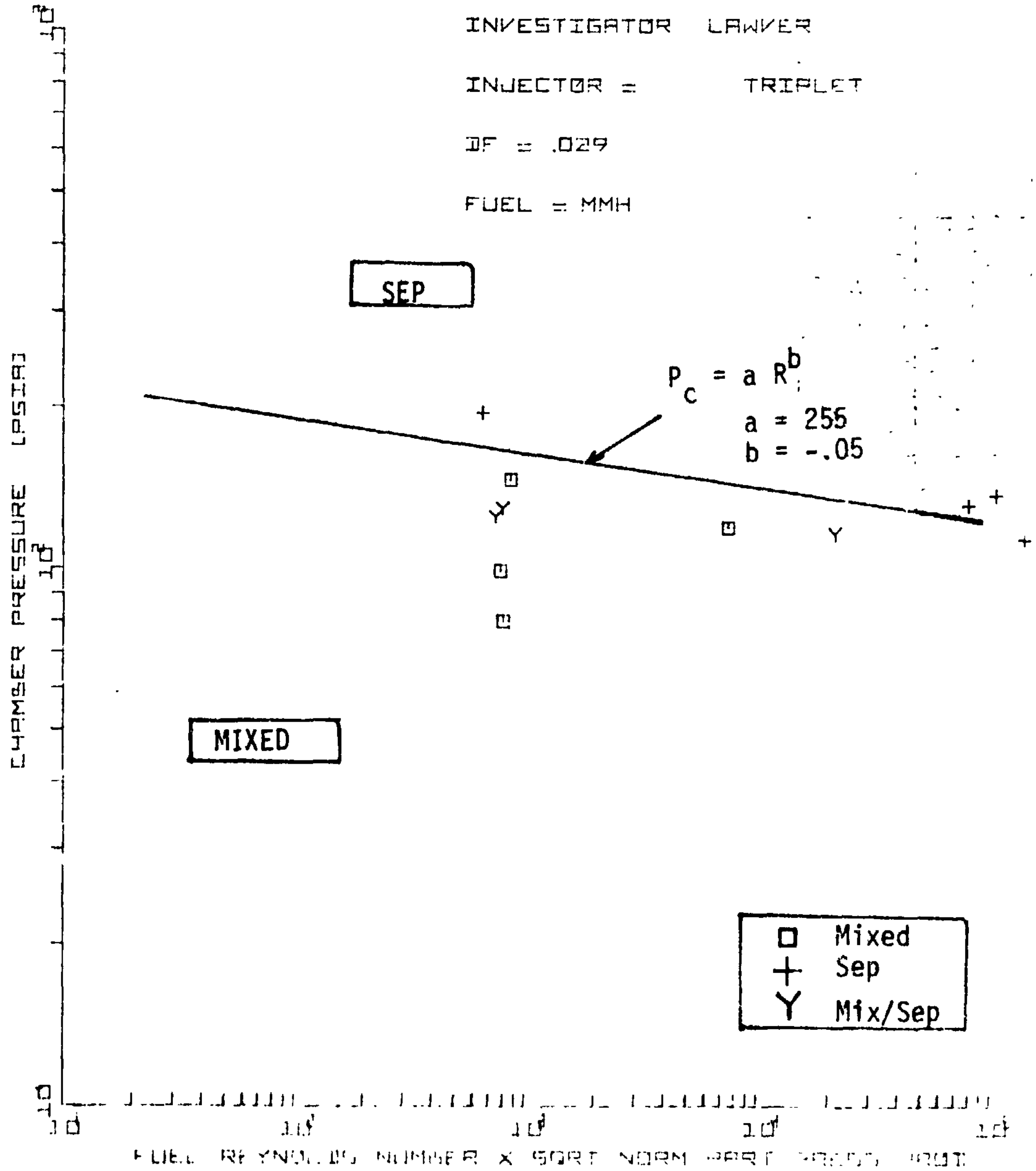

Figure B-9. Lawver Triplet, D_f = .029

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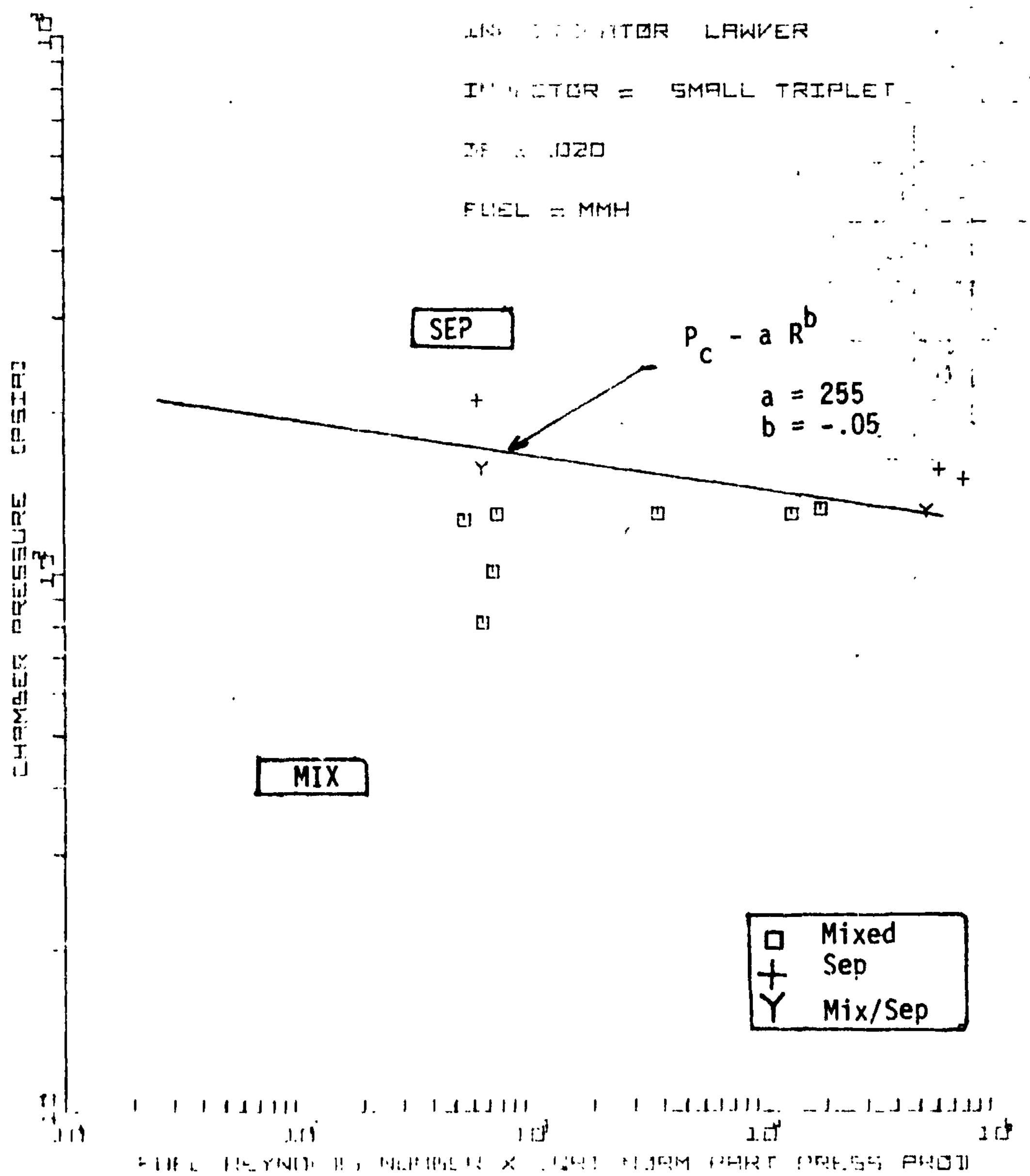

Figure 10. Lawver Small Triplet, D_f = .020

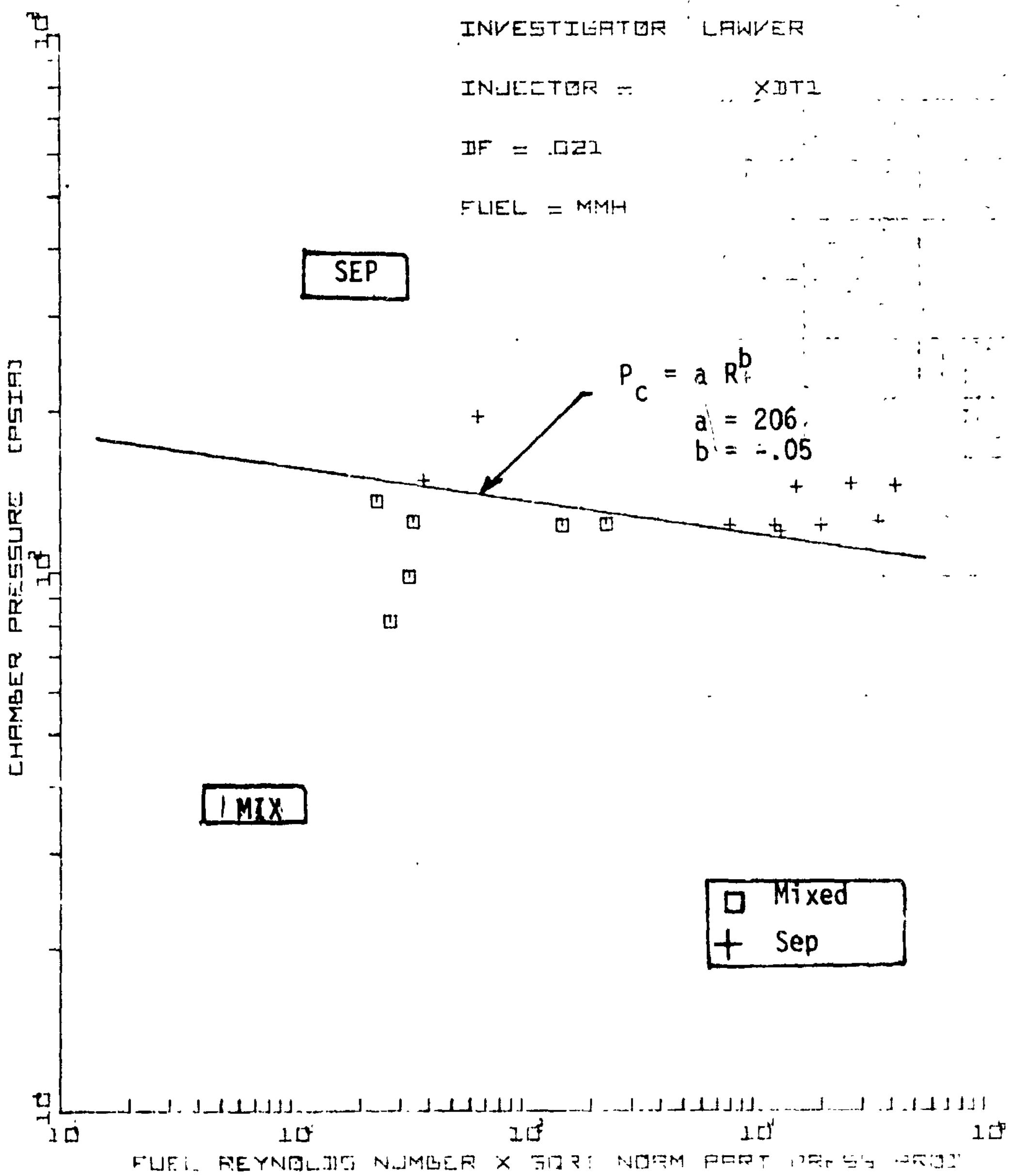

Figure B-11. Lawver XDT-1, D_f = .021

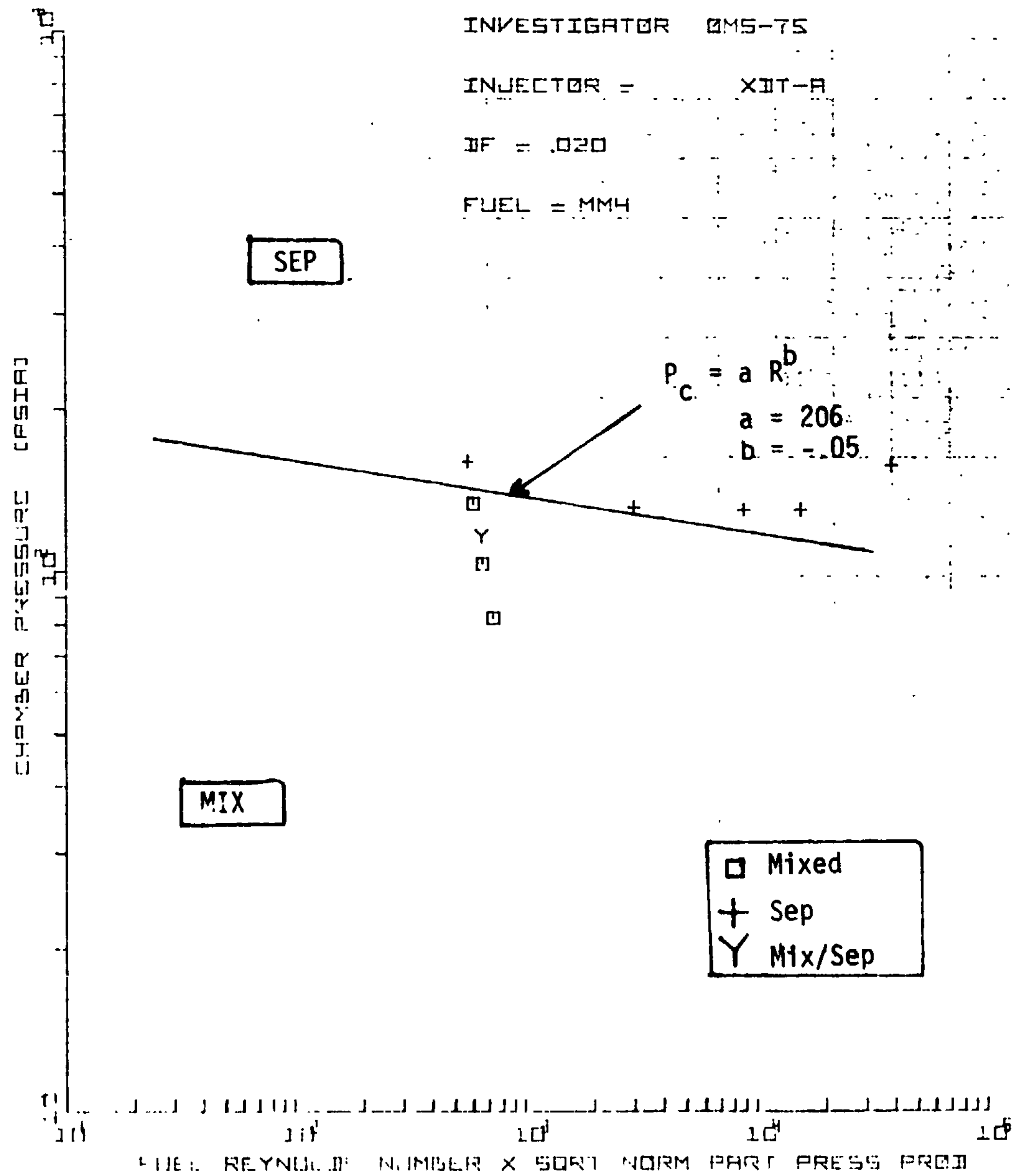

Figure B-12. OMS-75, XDT-A, D_f = .020

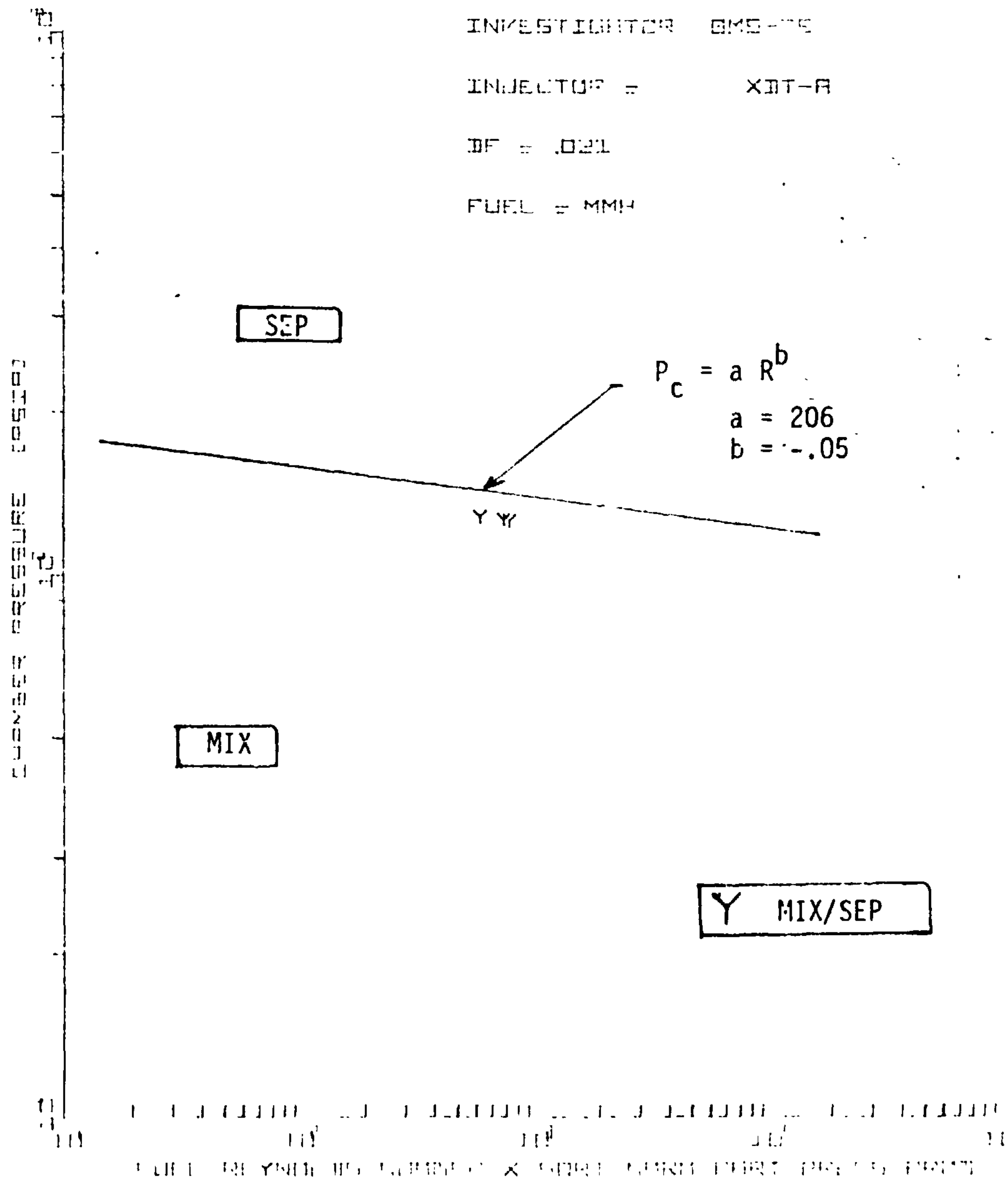

Figure B-13. OMS 75 XDT-A, D_f = .021

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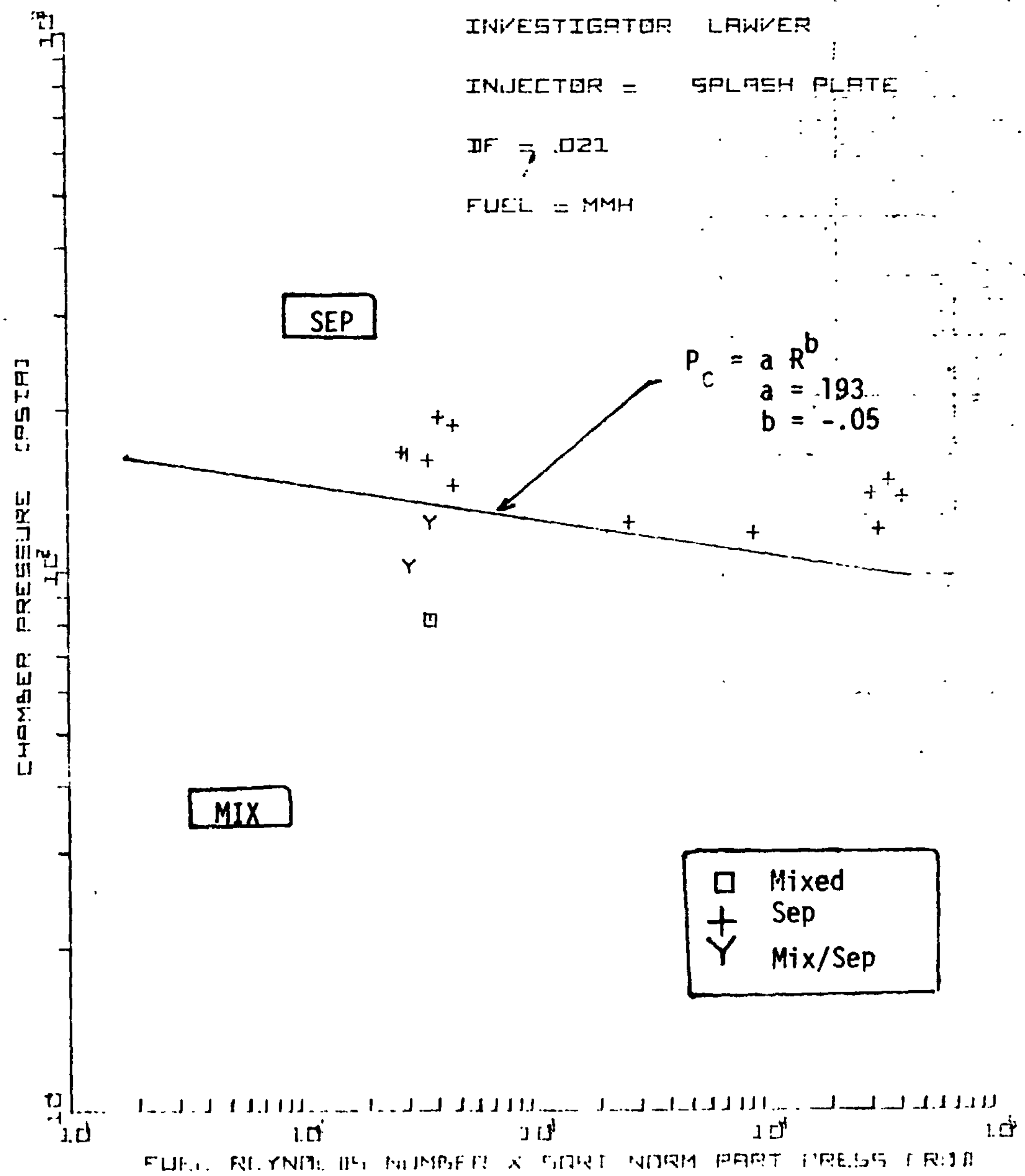

Figure B-14. Lawver Splash Plate, D_f = .021

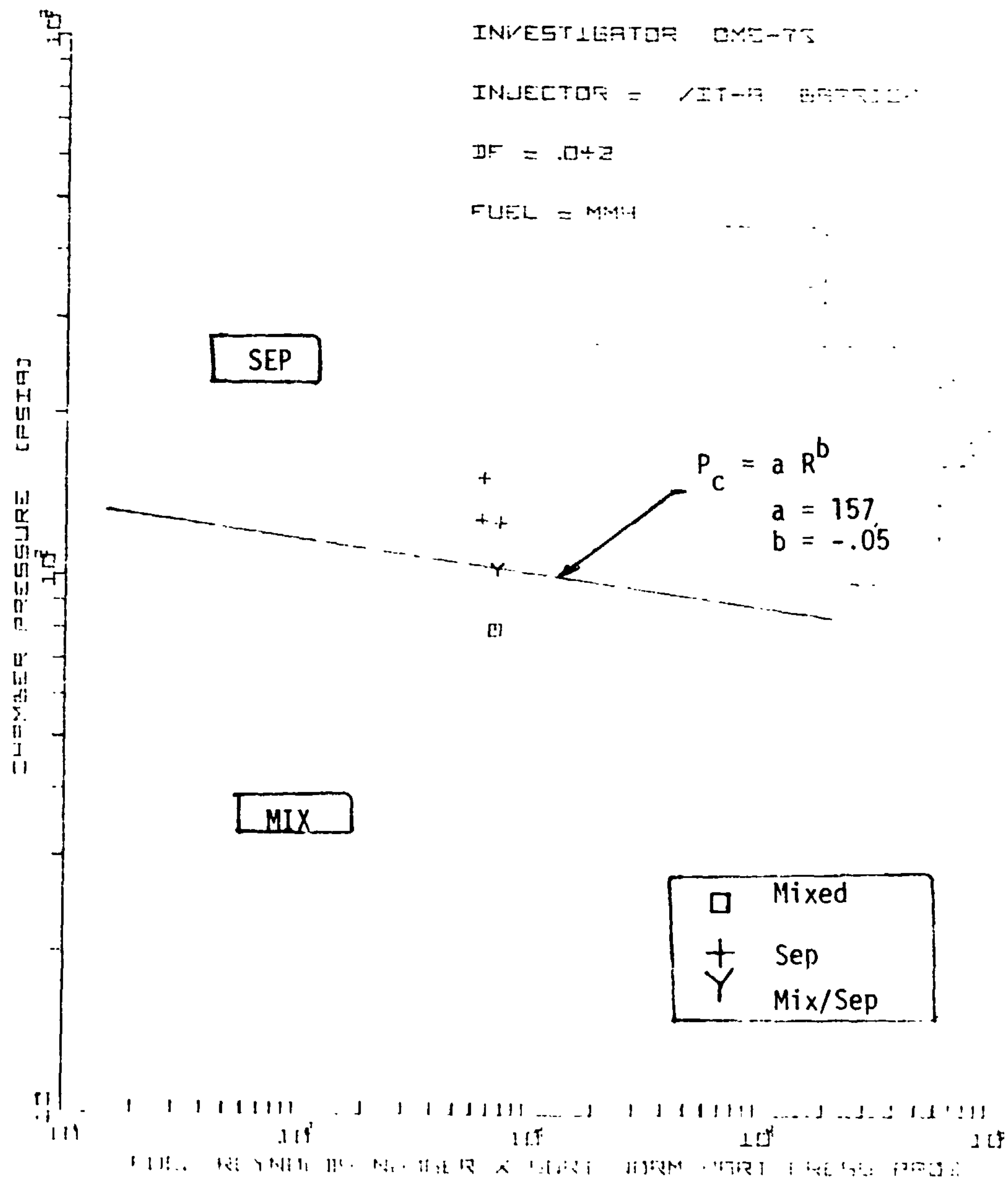

Figure B-15. OMS-75, VDT-A Barrier, D_f = 042

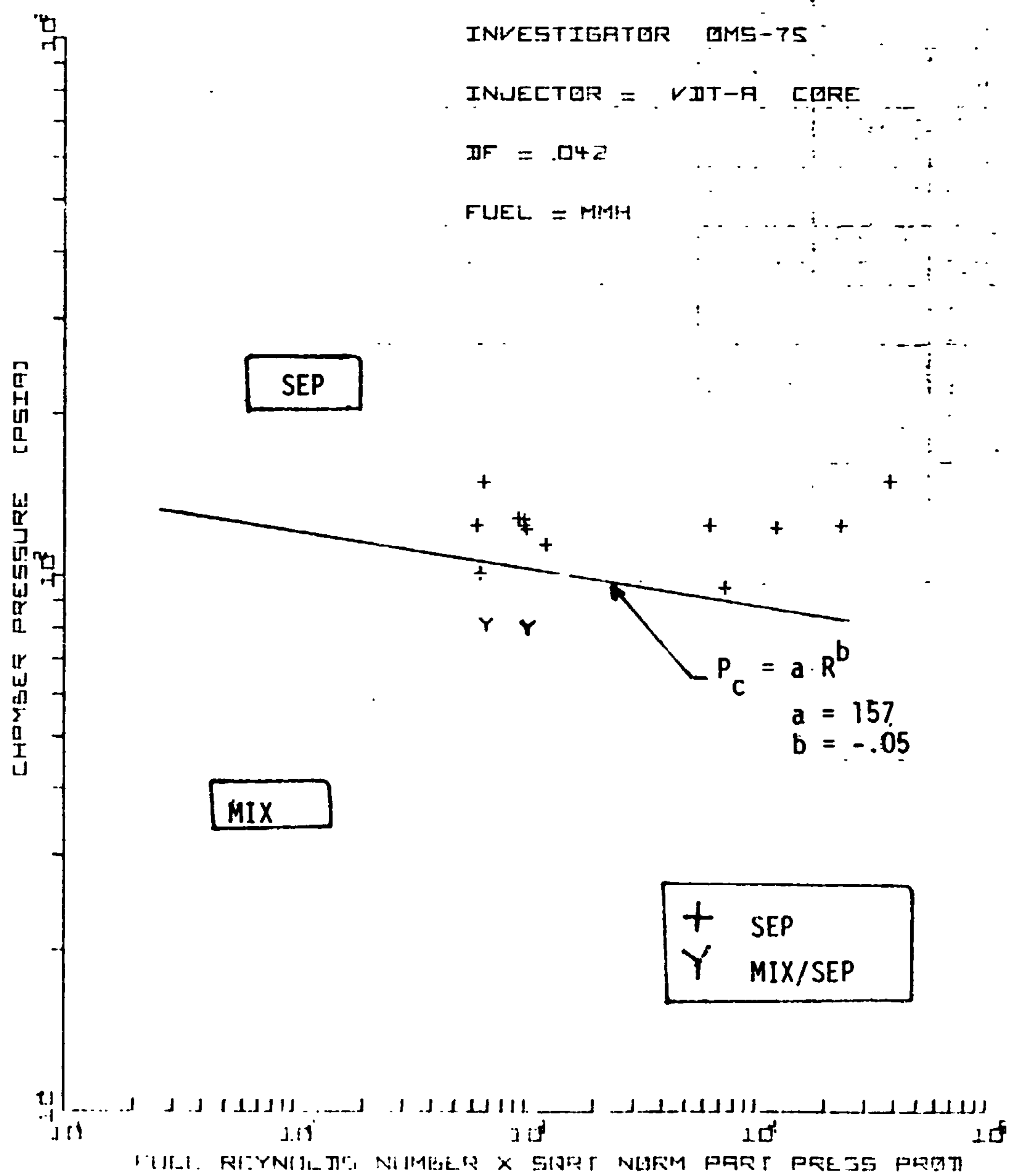

Figure B-16. OMS-75, VDT-A Core, D_f = .042

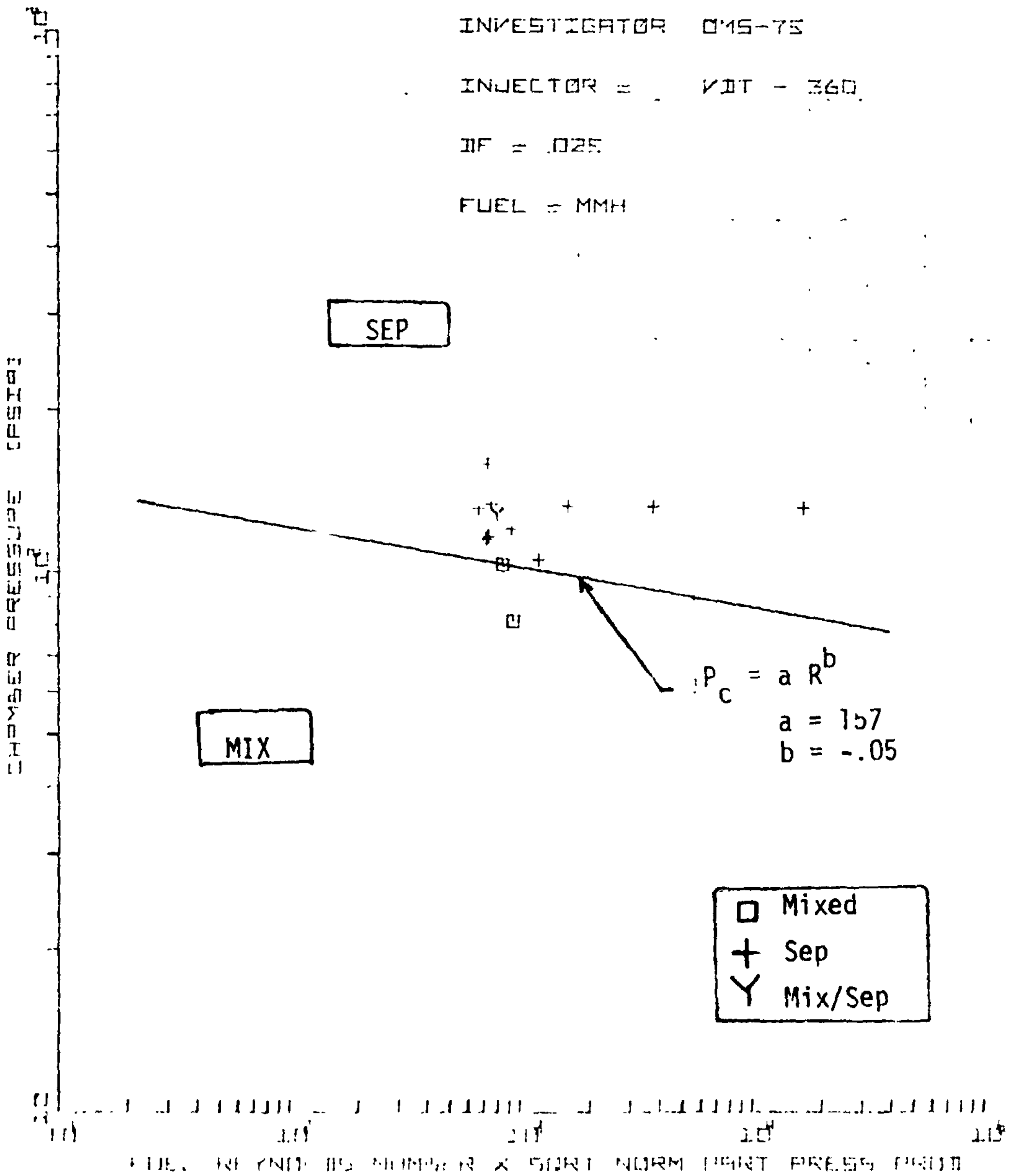

Figure B-17. OMS-75 VDT-360, D_f = .025

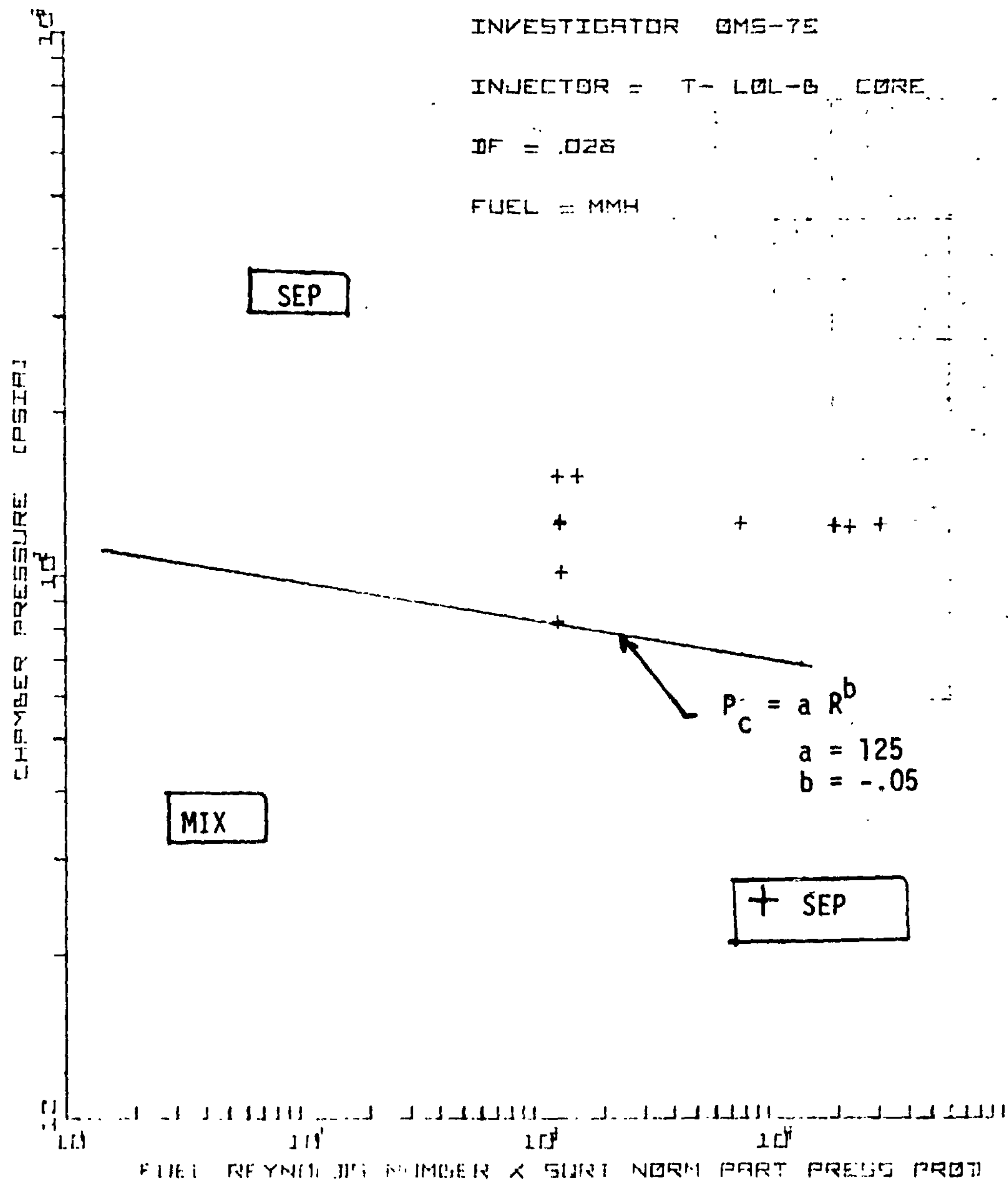

Figure B-18. OMS-75 T-LOL-B Core, D_f = .028

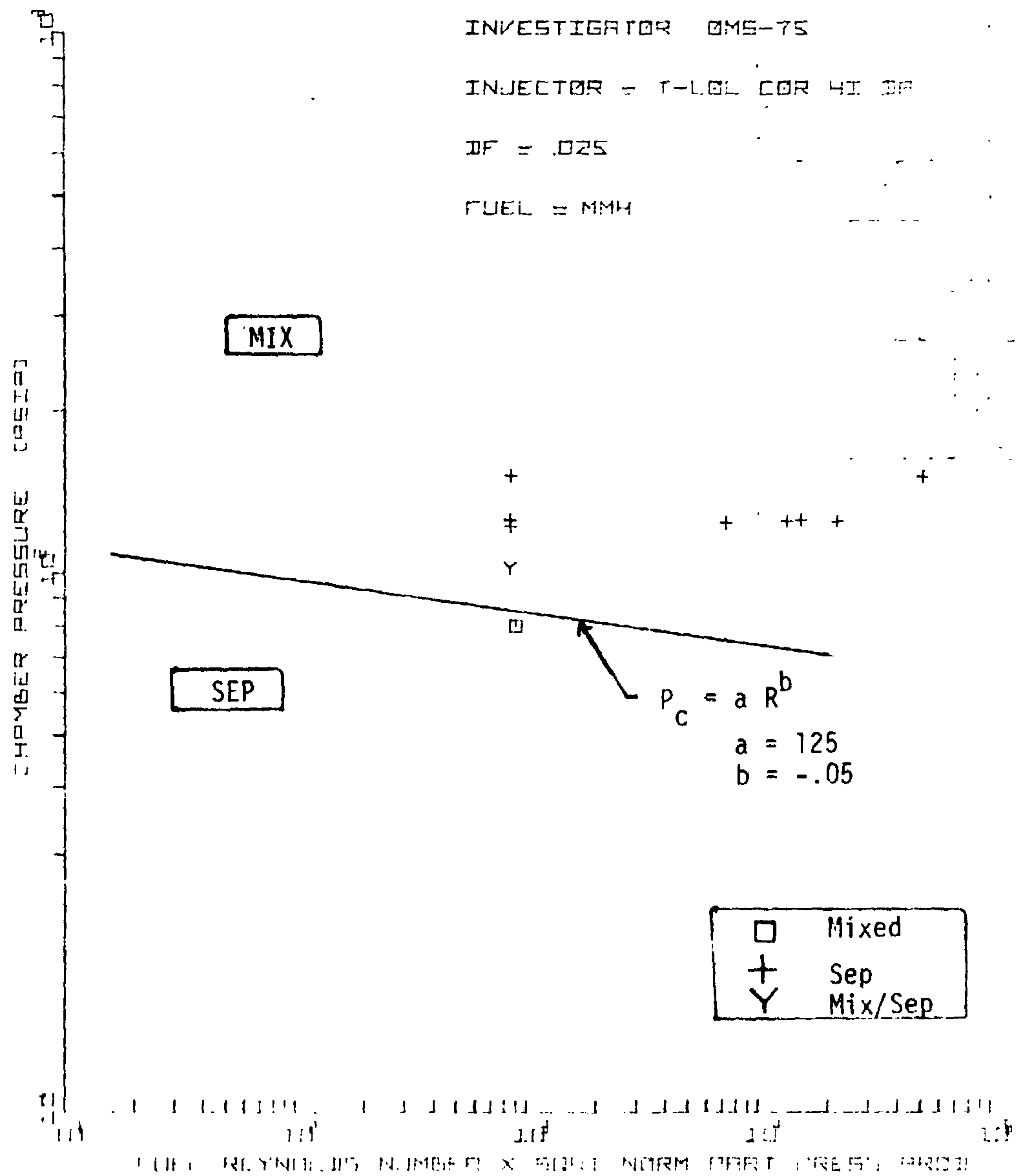

Figure B-19. OMS-75 T-LOL COR HI DP, D_f = .025

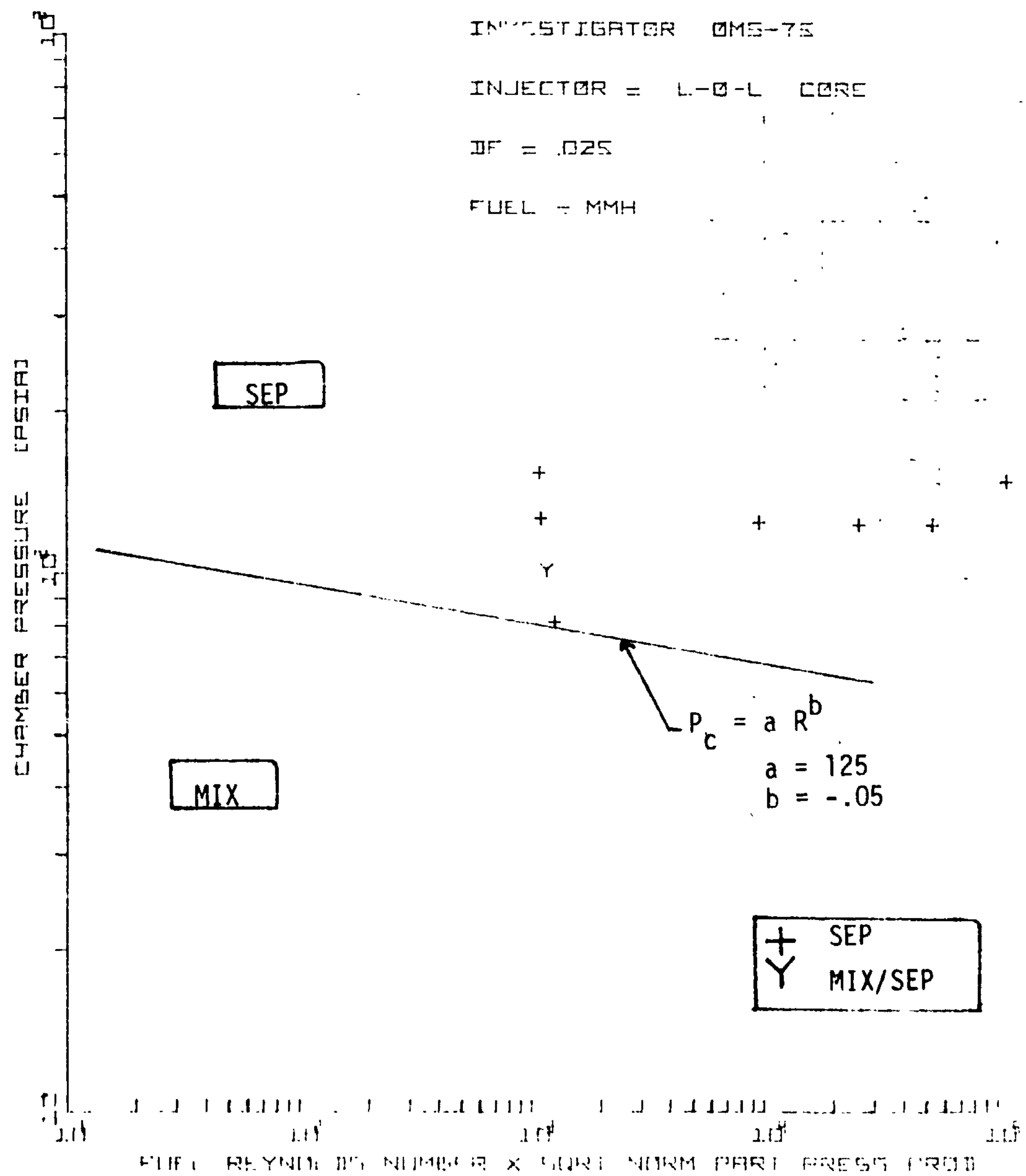

Figure B-20. OMS-75 LOL-CORE, D_f=.025

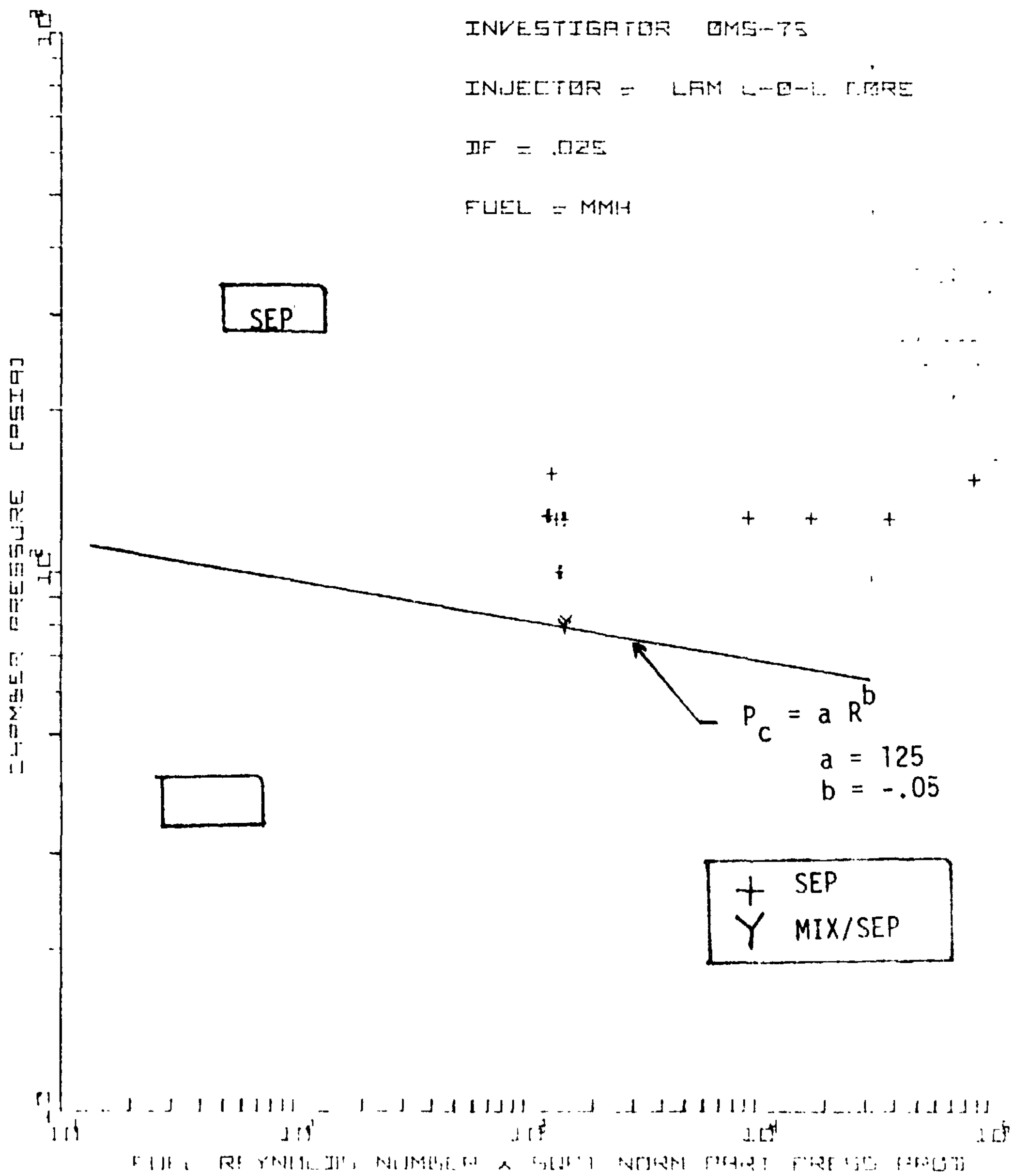

Figure B-21. OMS-75 LAR LOL CORE, D_f = .025

APPENDIX C

LIST OF CORRELATIONS EVALUATED

LIST OF CORRELATIONS EVALUATED

CORRELATION

P_c vs. D_F

P_c/D vs. T_f

P_c/D vs. $(D/V)_f$

P_c/D^2 vs. T_f

P_c vs. L/V_f

P_c vs. T_F

P_c vs. $\sqrt{XP}$

P_c vs. W_{e_f} $\sqrt{R_{e_f}}$ $\sqrt{P_{vo} \quad P_{vf}}$

P_c vs. $W_{e_f}\sqrt{P_{vo} \quad P_{vf}}$ $\frac{(D/V)_f}{P_c}$

*P_c vs. $R_{e_f}\sqrt{P_{vo} \quad P_{vf}}/P_c$

$1/T_f$ vs. $(D/V)_f$

$W_{e_f}\sqrt{R_{e_f}}$ vs. $\frac{P_{vo}\ P_{vf}}{P_c}$

$W_{e_f}\sqrt{R_{e_f}}$ vs. $\sqrt{P_{vo} \quad P_{vf}}$

$W_{e_f}\sqrt{R_{e_f}}$ vs. $\sqrt{P_{vo} \quad P_{vf}}$

*Best Correlation

APPENDIX D

TASK I - COMPUTER LISTINGS AND TASK I DATA SUMMARIES

APPENDIX D LIST OF SYMBOLS

D_F	Fuel orifice diameter, in
D_O	Oxidizer orifice diameter, in.
DV	Stream contact time, sec.
EM	Rupe Mixing efficiency
IS	ln (D/V sin 1/2 Imp. Angle) + 46.8 - 21800 1/T
Imp. Angle	Stream impingement included angle, °
L/D	Orifice length/diameter ratio
MF/MO	Fuel to oxidizer momentum ratio
MR	Mixture ratio, oxidizer/fuel
P_c	Chamber pressure, psia
R	Element spacing correlation coefficient, $R = 49.2\ DF/[PC]^{1/3}$
SPR	Fuel to oxidizer momentum flux ratio $(\rho V^2)_F/(\rho V^2)_{ox}$
TF	Fuel temperature, °F
TO	Oxidizer temperature, °F
VF	Fuel injection velocity, ft/sec
VO	Oxidizer injection velocity, ft/sec

TABLE D-I

REACTIVE STREAM SEPARATION AND POPPING CHRONOLOGY

DATE	INVESTIGATORS	ORGAN.	CONTRACT NO.	REFERENCE	PROPELLANTS	SENSING TECHNIQUES	ELEMENT TYPES	ELEMENT SIZE	PC RANGE	TEMP. RANGE	COMMENTS
1959	Elverum & Staudhammer	JPL	NAS [illegible]	Prog. Rpt. 30-4	N_2O_4/N_2H_4	Photographic	Single Element Unlike Doublet	Not Given	Atmos.	Ambient	First report of stream separation with hypergolic propellants.
1965	Johnson	JPL	NAS7-100	TR No. 32-639	N_2O_4/N_2H_4, MMH, UDMH, Furfuryl Alch. Corporal	Performance with Baffled Chamber	Single Element Unlike Doublet	.0236 Dia. 2000 lbf/Ele.	150 PSIA	Ambient	Quantitative performance measurement of stream separation. N_2O_4/N_2H_4, N_2O_4/MMH, and N_2O_4/UDMH showed some degree of blowapart. Corporal propellant showed blowapart to a lesser degree and N_2O_4/Furfural alcohol indicated no blow apart.
1966	Weiss & Klopoter	AFRPL	Proj. 624A	AFRPL-TR-66-51	N_2O_4/A-50, N_2O_4/N_2H_4, N_2O_4/MMH, N_2O_4/M-50	Pc Measurement	Transtage Quadlet	24 lbf/ele.	100 PSI	37-86°F	Provides popping data for Transtage injectors. Includes variations in propellant combination, injector type, manufacturing variations, mixture ratio and film cooling.
1967	Evans, Stanford & Riebling	JPL	NAS7-100	TR No. 32-1178	N_2O_4/N_2H_4	Performance with Baffled Chamber	Unlike Doublet & Imping. Sheet	10,100, 2000 lb/ele .022,.064, .236 Dia.	150 PSIA	Ambient	Stream separation found to be element size dependent; increasing with increasing element size. Impinging sheets exhibited less blowapart than impinging jets.
[illegible]	Burrows	NASA Lewis	In-house	NASA TM X-52244	N_2O_4/N_2H_4	Photographic, Thermocouple and emission spectra	Quadlet	.068 in. Dia.	19 Atmos.	Ambient	Stream separation observed with a unlike impingement quadlet element. Combustion product gases eventually mixed approximately 18 in. downstream of the injection point. Mixing obtained with like-on-like impingement quadlet element.
[illegible]	Lawver & Houseman	JPL	NAS7-100	NASA TM 33-395	N_2O_4/N_2H_4	None	Unlike Doublet	10-2000 lb/ele.	10-2000 PSIA	40-160°F	First theoretical model of stream separation for unlike doublet elements. Two separation regimes postulated; I liquid phase reactions controlling which applies at

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Table D-I (cont.)

DATE	INVESTIGATORS	ORGAN.	CONTRACT NO.	REFERENCE	PROPELLANTS	SENSING TECHNIQUES	ELEMENT TYPES	ELEMENT SIZE	PC RANGE	TEMP. RANGE	COMMENTS
											lower pressures where separation is dependent on contact time (D/V) and propellant temperature, and II gas phase reaction controlling which applies at higher pressures where separation is dependent on (D/V) and independent on propellant temperature. Model correlates previous JPL separation data.
1968	Burrows	NASA/ Lewis	In-house	NASA TMX-52483	N_2O_4/N_2H_4	Photographic	O-F-O & F-O-F Triplet	.025-.035-.025 Dia.	150-250 PSIA	Ambient	Stream separation observed for triplet elements.
1968	Lawver & Breen	Dynamic Science	NAS7-467	NASA-CR-72444	N_2O_4/N_2H_4	Photographic	Unlike Doublet	.025, .050, .100 in.	Atmos.	40-90°F	Developed a semi-empirical model in which separation is controlled by liquid phase mixing and kinetics, (D/V) and propellant temperature. A combustion "popping" regime was noted at lower temperatures and higher D/V values. Popping appeared to be caused by ignition within the entire impingement region of mixed liquid ligaments.
1969	Breen, Zung, Lawver, Kosvic & Coats	Dynamic Science	F04611-68-C-0040	AFRPL-TR-69-48	N_2O_4/N_2H_4 N_2O_4/MMH N_2O_4/A-50 ClF_5/N_2H_4	Photographic	Unlike Doublet Triplet	.025, .050, .150 Dia.	15-500 PSI	40-120 °F	Separation limits were defined for N_2O_4/N_2H_4 experimentally which were correlated with the liquid phase reaction chemical kinetics. Stream separation was observed to be independent of chamber pressure. Separation limits were observed at higher temperatures with N_2O_4/A-50 and N_2O_4/MMH as compared with the N_2O_4/N_2H_4 system. ClF_5/N_2H_4 always exhibited stream separation. "Popping" was postulated to be a function of element mixing level as well as D/V and propellant temperature

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TABLE D-I (cont.)

DATE	INVESTIGATORS	ORGAN.	CONTRACT NO.	REFERENCE	PROPELLANTS	SENSING TECHNIQUES	ELEMENT TYPES	ELEMENT SIZE	PC RANGE	TEMP RANGE	COMMENTS
1969	Rupe, Dipprey, Kushida, & Clayton		NAS7-100	CPIA Publ. No. 192	N_2O_4/A-50	Pc Measurement	Unlike Doublet	.142 & .073 Dia.	120 PSIA	30-105°F	Postulated that unlike doublet streams with equal stagnation pressure result in unstable operation or "pop". Correlation was demonstrated when a single element in an injector containing 72 elements was designed to operate at the unity pressure ratio. Pop free operation was attained without the element; 8 pops/second were obtained with the element.
1969	Houseman	JPL	NAS7-100	CPIA Publ. No. 192	N_2O_4/N_2H_4	Mass Spectrometer & C* Performance	Unlike Doublet	.020, .029, .073 Dia.	75-185 PSIA	40 F	Showed experimentally that jet mixing of hypergolic fluids can result in either penetrated, mixed, or separated regimes while operating at optimum cold flow mixing conditions
1969	Lawver	ALRC	NAS9-8285	ALRC TCER 9642:0106	N_2O_4/A-50	Photographic & Pc and Accelerometer measurements	Unlike Doublet (Apollo IOS)	21.5 lbf/ele	100 PSIA	Ambient	Developed semi-empirical model in which "popping" is the result of spray detonation which is triggered by a blastwave generated by small explosions associated with hypergolic stream impingement. High speed movie of a single doublet element impinging N_2O_4 and A-50 verified the cyclic separation or "popping" which could provide the trigger source. Model showed three conditions must be met for the occurrence of [illegible] popping; (1) stream impingement process must produce triggers, (2) element spacing must provide for coupling of the trigger explosion, and (3) element [illegible] ing efficiency must be adequate to promote [illegible] pop criteria were [illegible] using data from [illegible], PS, [illegible] IOS, and [illegible]

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TABLE D-I (cont.)

DATE	INVESTIGATORS	ORGAN.	CONTRACT NO.	REFERENCE	PROPELLANTS	SENSING TECHNIQUES	ELEMENT TYPES	ELEMENT SIZE	PC RANGE	TEMP. RANGE	COMMENTS
1970	Rodriguez and Axworthy	Rocketdyne	NAS7-739	NASA-CR-115863	N_2O_4/N_2H_4 N_2O_4/MMH N_2O_4/UDMH	Calorimetric & PVT measurements	Unlike Doublet	.028 Dia.	Atmos.	50°F	Experimentally measured the heat and gas release rates from hypergolic propellants reacting in the liquid phase. The reactivity with N_2O_4 was found to increase from hydrazine to UDMH to MMH.
1970	Clayton	JPL	NAS7 100	JPL TR-32-1479	N_2O_4/A-50 N_2O_4/Furfuryl alcohol	Pc Measurement	Unlike Doublet	.042 & .073 Dia.	120-300 PSIA	40-100°F	Provides popping data from 130 tests with a 18 in. dia engine which was fired in a cylindrical and annular configuration. Separate flow control permitted changes in the relative boundary, outer core, and inner core, elements flow conditions. Concludes that impingement stream stagnation dynamics are significant in engine "popping". Equal dynamic pressure maximizes the tendency to produce pops. Poping occurrence and frequency was temperature sensitive. No pops were obtained at Pc = 300 psia and reduced popping was noted with furfuryl alcohol.
1970	Lee & Houseman	JPL	NAS7-100	Paper presented at West. States Comb. Inst. Meeting Oct. 1970	N_2O_4/N_2H_4 N_2O_4/MMH N_2O_4/UDMH	Pc Meas. & Photographic	Unlike Doublet	.073, .100, & .173 Dia.	Atmos. to 450 PSIA	40-140°F	Presented experimental data and correlations which show that Pc, D_j, and V_j are controlling parameters for "popping" with high pressure or low contact time (D/V) eliminating pops. N_2H_4 and MMH exhibit similar popping trends, UDMH has relatively little tendency to pop. Popping rate noted to decrease with temperature and stagnation pressure ratio had only a small effect on popping rate.

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TABLE D-I (cont.)

DATE	INVESTIGATORS	ORGAN.	CONTRACT NO.	REFERENCE	PROPELLANTS	SENSING TECHNIQUES	ELEMENT TYPES	ELEMENT SIZE	PC RANGE	TEMP. RANGE	COMMENTS
1971	Zung & White	Dynamic Science	NAS3-12031	NAS CR-1704	N_2O_4/N_2H_4	Photographic & Chamber Pressure Measurement	Unlike Doublet	.027, .040, .055, & .060 Dia.	15-500 PSIA	40-140 °F	Presents results from nearly 500 tests with variation in temp, Pc, and D_j. Empirically determined operating regimes for "popping", stream mixing, and stream separation. The occurrence of popping was found to be chamber pressure and orifice size dependent; occurring at low Pc and Large D_j and absent at high Pc (> 185 psia) and/or small D_j. Identified two regimes of separated flow; one at low pressures and N_2O_4 temperatures above the boiling point resulting in significant N_2O_4 vaporization prior to impingement and one at high pressures with conventional liquid-liquid impingement. Mixed flow was observed at low pressures (< 230 psi) and temperatures below the N_2O_4 boiling point.
1971	Nurick & Cordill	Rocketdyne	NAS7-720	NASA-CR-119246	N_2O_4/N_2H_4 N_2O_4/A-50 IRFNA/UDMH ClF_5/N_2H_4	Photographic	Unlike Doublet	.030, .072, & .173 Dia.	Atmos. & 200 PSIA	-10 to 80°F	Observed cyclic blowapart ("popping") with N_2O_4/N_2H_4 (most violent), N_2O_4/A-50 and IRFNA/UDMH (least violent). Operating conditions reduced both the strength and frequency of "popping", decreasing with decreasing D_j and increasing V_j, chamber pressure (to 200 PSIA) had little effect of "popping". Dynamic pressure ratio (0.9-1.5) produced some variation in the popping frequency. No continuous stream separation noted with N_2O_4, but continuous stream separation was observed with ClF_5/N_2H_4 at all conditions except small D_j and high dynamic pressure ratio.

TABLE D-I (cont.)

DATE	INVESTIGATORS	ORGAN.	CONTRACT NO.	REFERENCE	PROPELLANTS	SENSING TECHNIQUES	ELEMENT TYPES	ELEMENT SIZE	PC RANGE	TEMP. RANGE	COMMENTS
1973	OMS Program	ALRC	In-House	-	N_2O_4/MMH N_2O_4/A-50	Performance Measurement (Isp &C*)	Unlike Doublet	D_o=.033, D_F=.028; D_o=.031, D_F=.028; D_o=.024, D_F=.020	125-150 PSIA	40-250°F Fuel Ambient Oxidizer	Subscale (1000 lbf) and fullscale (6000 lbf) OMS injectors demonstrated decreasing performance with increasing fuel temperature. Performance data showed a continuously decreasing performance efficiency with increasing fuel temperature. Performance decrease is lessened with increasing chamber length (4-12 in.). A-50 data showed slight increase in efficiency to 100°F then continuously decreasing efficiency.
1973	OMS Program	Rocketdyne	NAS9-12802	ASR73-27	N_2O_4/MMH	Performance Measurement (C*)	Like-on-Like Doublet	D_o=.026, D_F=.024	100-140 PSIA	80-250°F Fuel Ambient Oxidizer	Single element testing with a 3.9 inch chamber showed continuous C* efficiency decrease with increasing fuel temperature for all elements tested. No performance change noted with full scale OMS injector tested with long chambers (12-20 in.)
1973	OMS Program	Bell Aero-Space Co.	NAS9-12803	Data Dump	N_2O_4/MMH	Performance Measurement (C*)	F-O-F Triplet	D_o=.05, D_F=.03	125 PSIA	40-200°F Fuel Ambient Oxidizer	C* efficiency decrease of 1/2-1% as fuel temperature increased from ambient to 200°F.
1973	OMS Program	ALRC	In-House	-	N_2O_4/MMH	Performance & Pc Measurement	Like-On-Like Doublet	D_o=.027, D_F=.025	110-140 PSIA	50-210°F Fuel Ambient Oxidizer	Full scale OMS injector showed slight decrease (0.1%) in performance efficiency from ambient to hot fuel with long chamber (16 in.). Axial Pc measurements indicate lower combustion near injector with hot fuel which is nearly damped at the end of the combustion chamber.

TABLE NO. D-II

HYPERGOLIC STREAM IMPINGMENT DATA COMPLIATION**

INVESTIGATOR NURICK[14]** A L R C MODEL CORRELATION PARAMETERS

FUEL TYPE	TEST NO.	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	COMMENTS	*	PD	IS	R (IN)	EM	SPR	nV (SEC)
N2H4	9	.173	.173	100.	45.	13.7	33.0	43.0	55.0	60.0	.000	.860	POP	*	79.2	.115	3.560	.987	1.173	.34-03
N2H4	10	.173	.173	100.	45.	13.7	33.0	43.0	55.0	62.0	.000	.860	POP	*	79.2	.135	3.560	.988	1.172	.34-03
N2H4	11	.173	.173	100.	45.	13.7	33.0	41.0	55.0	58.0	.000	.910	POP	*	79.2	.103	3.560	.998	1.067	.35-03
N2H4	12	.173	.173	100.	45.	13.7	33.0	41.0	52.0	67.0	.000	.930	POP	*	79.2	.210	3.560	.998	1.060	.35-03
N2H4	13	.173	.173	100.	45.	13.7	30.0	36.0	55.0	55.0	.000	1.000	POP	*	79.2	.091	3.560	1.000	.997	.40-03
N2H4	14	.173	.173	100.	45.	13.7	30.0	36.0	55.0	55.0	.000	1.000	POP	*	79.2	.091	3.560	1.000	.997	.40-03
N2H4	15	.173	.173	100.	45.	13.7	30.0	40.0	55.0	55.0	.000	.850	POP	*	79.2	.082	3.560	.979	1.231	.36-03
N2H4	16	.173	.173	100.	45.	13.7	28.0	41.0	55.0	65.0	.000	.690	POP	*	79.2	.180	3.560	.927	1.477	.35-03
N2H4	17	.173	.173	100.	45.	13.7	28.0	43.0	55.0	65.0	.000	.630	POP	*	79.2	.171	3.560	.890	1.625	.34-03
N2H4	18	.173	.173	100.	45.	13.7	30.0	43.0	55.0	65.0	.000	.830	POP	*	79.2	.171	3.560	.942	1.416	.34-03
N2H4	19	.173	.173	100.	45.	13.7	32.0	43.0	55.0	65.0	.000	.880	POP	*	79.2	.171	3.560	.976	1.244	.34-03
N2H4	20	.173	.173	100.	45.	13.7	33.0	43.0	55.0	65.0	.000	.910	POP	*	79.2	.171	3.560	.988	1.170	.34-03
N2H4	21	.173	.173	100.	45.	13.7	33.0	43.0	55.0	65.0	.000	.910	POP	*	79.2	.171	3.560	.988	1.170	.34-03
N2H4	22	.072	.072	100.	60.	13.7	38.0	50.0	45.0	55.0	.000	.850	POP	*	190.3	.021	1.482	.985	1.189	.12-03
N2H4	23	.072	.072	100.	60.	13.7	51.0	63.0	45.0	55.0	.000	.940	POP	*	190.3	.017	1.482	.999	1.048	.95-04
N2H4	24	.030	.030	100.	60.	13.7	47.0	56.0	45.0	55.0	.000	1.000	MIX	*	456.7	.008	.617	1.000	.975	.45-04
N2H4	25	.030	.030	100.	60.	13.7	47.0	56.0	45.0	55.0	.000	1.000	MIX	*	456.7	.008	.617	1.000	.975	.45-04
N2H4	26	.030	.030	100.	60.	13.7	46.0	54.0	45.0	55.0	.000	1.030	MIX	*	456.7	.008	.617	.998	.946	.46-04
N2H4	27	.173	.173	100.	60.	13.7	41.6	56.2	40.0	40.0	.000	1.260	POP	*	79.2	.013	3.560	.974	1.257	.26-03
N2H4	28	.173	.173	100.	60.	13.7	40.3	51.9	40.0	40.0	.000	1.150	POP	*	79.2	.014	3.560	.991	1.142	.28-03
N2H4	29	.173	.173	100.	60.	13.7	40.5	51.9	40.0	40.0	.000	1.140	POP	*	79.2	.014	3.560	.992	1.131	.28-03
N2H4	30	.173	.173	100.	60.	13.7	42.3	48.5	40.0	40.0	.000	.900	POP	*	79.2	.015	3.560	.995	.905	.30-03
N2H4	32	.173	.173	100.	60.	13.7	41.3	50.1	40.0	40.0	.000	1.020	POP	*	79.2	.014	3.560	1.000	1.014	.29-03
N2H4	33	.173	.173	100.	60.	13.7	39.2	49.2	40.0	40.0	.000	1.090	POP	*	79.2	.014	3.560	.997	1.085	.29-03
A-50	44	.173	.173	100.	60.	13.7	38.0	52.0	40.0	50.0	.000	1.280	POP	*	79.2	.032	3.560	.990	1.151	.28-03
A-50	45	.173	.173	100.	60.	13.7	40.2	51.3	40.0	50.0	.000	1.040	POP	*	79.2	.032	3.560	1.000	1.001	.28-03
A-50	46	.173	.173	100.	60.	13.7	40.2	51.6	40.0	50.0	.000	1.050	POP	*	79.2	.032	3.560	1.000	1.012	.28-03
A-50	47	.173	.173	100.	60.	13.7	40.2	51.4	40.0	50.0	.000	1.040	POP	*	79.2	.032	3.560	1.000	1.005	.28-03
A-50	53	.173	.173	100.	60.	235.0	39.8	64.5	40.0	45.0	.000	1.500	POP	*	1358.4	.017	1.382	.892	1.617	.22-03
A-50	54	.173	.173	100.	60.	225.0	39.8	55.0	40.0	45.0	.000	1.100	POP	*	1300.6	.020	1.402	.987	1.176	.26-03
A-50	55	.173	.173	100.	60.	225.0	40.4	53.0	40.0	45.0	.000	.990	POP	*	1300.6	.021	1.402	.998	1.060	.27-03
A-50	56	.173	.173	100.	60.	220.0	40.4	52.0	40.0	45.0	.000	.960	POP	*	1271.7	.021	1.412	1.000	1.020	.28-03

*See Appendix A Nomenclature for Symbol Definitions

**Ref. 4

HYPERGOLIC STREAM IMPINGMENT DATA COMPLIATION

INVESTIGATOR HOUSEMAN *

A L R C MODEL CORRELATION PARAMETERS

FUEL TYPE	TEST NO.	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	COMMENTS	*	PD	IS	R (IN)	EM	SPR	DV (SEC)
N2H4	1	.073	.073	100.	45.	14.2	38.2	38.2	70.0	70.0	1.200	1.000	POP	*	194.5	.120	1.484	.937	.696	.16-03
N2H4	2	.073	.073	100.	45.	16.0	36.1	36.1	70.0	70.0	1.200	1.000	POP	*	219.2	.127	1.427	.937	.696	.17-03
N2H4	3	.073	.073	100.	45.	42.0	36.8	36.8	70.0	70.0	1.200	1.000	MIX	*	575.3	.125	1.035	.937	.696	.17-03
N2H4	4	.073	.073	100.	45.	14.2	46.3	46.3	70.0	70.0	1.200	1.000	POP	*	194.5	.099	1.484	.937	.696	.13-03
N2H4	5	.073	.073	100.	45.	18.0	45.1	45.1	70.0	70.0	1.200	1.000	POP	*	246.6	.102	1.372	.937	.696	.13-03
N2H4	6	.073	.073	100.	45.	56.0	46.3	46.3	70.0	70.0	1.200	1.000	MIX	*	767.1	.099	.940	.937	.696	.13-03
N2H4	7	.073	.073	100.	45.	14.2	58.2	58.2	70.0	70.0	1.200	1.000	POP	*	194.5	.079	1.484	.937	.696	.10-03
N2H4	8	.073	.073	100.	45.	23.0	55.9	55.9	70.0	70.0	1.200	1.000	MIX	*	315.1	.082	1.264	.937	.696	.11-03
N2H4	9	.073	.073	100.	45.	73.0	60.8	60.8	70.0	70.0	1.200	1.000	POP	*	1000.0	.076	.861	.937	.696	.10-03
N2H4	10	.073	.073	100.	45.	14.2	73.0	73.0	70.0	70.0	1.200	1.000	POP	*	194.5	.063	1.484	.937	.696	.83-04
N2H4	11	.073	.073	100.	45.	29.0	70.8	70.8	70.0	70.0	1.200	1.000	MIX	*	397.3	.065	1.170	.937	.696	.86-04
N2H4	12	.073	.073	100.	45.	14.2	127.8	127.8	70.0	70.0	1.200	1.000	MIX	*	194.5	.036	1.484	.937	.696	.48-04
N2H4	13	.073	.073	100.	45.	52.0	123.9	123.9	70.0	70.0	1.200	1.000	POP	*	712.3	.037	.964	.937	.696	.49-04
N2H4	14	.073	.073	100.	45.	120.0	115.2	115.2	70.0	70.0	1.200	1.000	MIX	*	1643.8	.040	.729	.937	.696	.53-04
N2H4	15	.100	.100	100.	45.	14.2	19.1	19.1	70.0	70.0	1.200	1.000	POP	*	142.0	.330	2.034	.937	.696	.44-03
N2H4	16	.100	.100	100.	45.	28.0	19.8	19.8	70.0	70.0	1.200	1.000	POP	*	280.0	.318	1.622	.937	.696	.42-03
N2H4	17	.100	.100	100.	45.	68.0	19.0	19.0	70.0	70.0	1.200	1.000	POP	*	680.0	.332	1.207	.937	.696	.44-03
N2H4	18	.100	.100	100.	45.	14.2	28.5	28.5	70.0	70.0	1.200	1.000	POP	*	142.0	.221	2.034	.937	.696	.29-03
N2H4	19	.100	.100	100.	45.	19.0	29.6	29.6	70.0	70.0	1.200	1.000	POP	*	190.0	.213	1.846	.937	.696	.28-03
N2H4	20	.100	.100	100.	45.	42.0	27.9	27.9	70.0	70.0	1.200	1.000	POP	*	420.0	.226	1.417	.937	.696	.30-03
N2H4	21	.100	.100	100.	45.	110.0	28.3	28.3	70.0	70.0	1.200	1.000	POP	*	1100.0	.223	1.028	.937	.696	.29-03
N2H4	22	.100	.100	100.	45.	14.2	37.3	37.3	70.0	70.0	1.200	1.000	POP	*	142.0	.169	2.034	.937	.696	.22-03
N2H4	23	.100	.100	100.	45.	23.0	38.6	38.6	70.0	70.0	1.200	1.000	MIX	*	230.0	.163	1.732	.937	.696	.22-03
N2H4	24	.100	.100	100.	45.	52.0	39.9	39.9	70.0	70.0	1.200	1.000	POP	*	520.0	.158	1.320	.937	.696	.21-03
N2H4	25	.100	.100	100.	45.	154.0	37.8	37.8	70.0	70.0	1.200	1.000	POP	*	1540.0	.167	.919	.937	.696	.22-03
N2H4	26	.100	.100	100.	45.	14.2	66.3	66.3	70.0	70.0	1.200	1.000	POP	*	142.0	.095	2.034	.937	.696	.13-03
N2H4	27	.100	.100	100.	45.	35.0	62.9	62.9	70.0	70.0	1.200	1.000	MIX	*	350.0	.100	1.506	.937	.696	.13-03
N2H4	28	.100	.100	100.	45.	250.0	63.2	63.2	70.0	70.0	1.200	1.000	POP	*	2500.0	.100	.782	.937	.696	.13-03
N2H4	29	.100	.100	100.	45.	54.0	117.4	117.4	70.0	70.0	1.200	1.000	POP	*	540.0	.054	1.303	.937	.696	.71-04
N2H4	30	.100	.100	100.	45.	118.0	145.0	145.0	70.0	70.0	1.200	1.000	MIX	*	1180.0	.043	1.005	.937	.696	.57-04
N2H4	31	.073	.073	100.	45.	14.2	40.0	40.0	70.0	70.0	1.200	1.000	POP	*	194.5	.115	1.484	.937	.696	.15-03
N2H4	32	.073	.073	100.	45.	450.0	32.3	32.3	70.0	70.0	1.200	1.000	POP	*	6164.4	.142	.470	.937	.696	.19-03
N2H4	33	.073	.073	100.	45.	14.2	21.6	21.6	70.0	70.0	1.200	1.000	POP	*	194.5	.213	1.484	.937	.696	.28-03
N2H4	34	.073	.073	100.	45.	94.0	20.5	20.5	70.0	70.0	1.200	1.000	POP	*	1287.7	.224	.791	.937	.696	.30-03
N2H4	35	.073	.073	100.	45.	250.0	18.7	18.7	70.0	70.0	1.200	1.000	POP	*	3424.7	.246	.571	.937	.696	.33-03
N2H4	36	.073	.073	100.	45.	28.0	71.0	71.0	70.0	70.0	1.200	1.000	MIX	*	383.6	.065	1.184	.937	.696	.86-04
N2H4	37	.073	.073	100.	45.	28.0	24.0	24.0	70.0	70.0	1.200	1.000	POP	*	383.6	.192	1.184	.937	.696	.25-03
N2H4	38	.100	.100	100.	45.	28.0	20.0	20.0	70.0	70.0	1.200	1.000	POP	*	280.0	.315	1.622	.937	.696	.42-03
N2H4	39	.173	.173	100.	45.	28.0	5.4	5.4	70.0	70.0	1.200	1.000	POP	*	161.8	2.019	2.806	.937	.696	.27-02
N2H4	40	.073	.073	100.	45.	43.0	60.0	60.0	70.0	70.0	1.200	1.000	MIX	*	589.0	.077	1.026	.937	.696	.10-03

*Ref. 5

HYPERGOLIC STREAM IMPINGMENT DATA COMPLIATION

INVESTIGATOR HOUSEMAN

A L R C MODEL CORRELATION PARAMETERS

FUEL TYPE	TEST NO.	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	COMMENTS	*	PM	IS	R (IN)	EM	SPR	DV (SEC)
N2H4	41	.073	.073	100.	45.	43.0	37.0	37.0	70.0	70.0	1.200	1.000	MIX	*	589.0	.124	1.026	.937	.696	.16-03
N2H4	42	.100	.100	100.	45.	43.0	28.0	28.0	70.0	70.0	1.200	1.000	MIX	*	430.0	.225	1.406	.937	.696	.30-03
N2H4	43	.100	.100	100.	45.	43.0	28.0	28.0	70.0	70.0	1.200	1.000	MIX	*	430.0	.225	1.406	.937	.696	.30-03
N2H4	44	.173	.173	100.	45.	43.0	8.0	8.0	70.0	70.0	1.200	1.000	POP	*	248.6	1.363	2.433	.937	.696	.18-02
N2H4	45	.073	.073	100.	45.	52.0	124.0	124.0	70.0	70.0	1.200	1.000	POP	*	712.3	.037	.964	.937	.696	.49-04
N2H4	46	.073	.073	100.	45.	52.0	44.0	44.0	70.0	70.0	1.200	1.000	MIX	*	712.3	.105	.964	.937	.696	.14-03
N2H4	47	.100	.100	100.	45.	52.0	40.0	40.0	70.0	70.0	1.200	1.000	MIX	*	520.0	.158	1.320	.937	.696	.21-03
N2H4	48	.100	.100	100.	45.	52.0	40.0	40.0	70.0	70.0	1.200	1.000	POP	*	520.0	.158	1.320	.937	.696	.21-03
N2H4	49	.173	.173	100.	45.	52.0	10.0	10.0	70.0	70.0	1.200	1.000	POP	*	300.6	1.090	2.283	.937	.696	.14-02
N2H4	50	.073	.073	100.	45.	70.0	61.0	61.0	70.0	70.0	1.200	1.000	POP	*	958.9	.075	.873	.937	.696	.10-03
N2H4	51	.100	.100	100.	45.	70.0	51.0	51.0	70.0	70.0	1.200	1.000	POP	*	700.0	.124	1.195	.937	.696	.16-03
N2H4	52	.100	.100	100.	45.	70.0	20.0	20.0	70.0	70.0	1.200	1.000	POP	*	700.0	.315	1.195	.937	.696	.42-03
N2H4	53	.073	.073	100.	45.	100.0	91.0	91.0	70.0	70.0	1.200	1.000	POP	*	1369.9	.051	.775	.937	.696	.67-04
N2H4	54	.100	.100	100.	45.	100.0	80.0	80.0	70.0	70.0	1.200	1.000	POP	*	1000.0	.079	1.062	.337	.696	.10-03
N2H4	55	.173	.173	100.	45.	100.0	21.0	21.0	70.0	70.0	1.200	1.000	POP	*	578.0	.519	1.837	.937	.696	.69-03
N2H4	56	.173	.173	100.	45.	100.0	16.0	16.0	70.0	70.0	1.200	1.000	POP	*	578.0	.682	1.837	.937	.696	.90-03
N2H4	57	.073	.073	100.	45.	120.0	115.0	115.0	70.0	70.0	1.200	1.000	MIX	*	1643.8	.040	.729	.937	.696	.53-04
N2H4	58	.100	.100	100.	45.	120.0	145.0	145.0	70.0	70.0	1.200	1.000	MIX	*	1200.0	.043	.999	.937	.696	.57-04
N2H4	59	.173	.173	100.	45.	120.0	17.0	17.0	70.0	70.0	1.200	1.000	POP	*	693.6	.641	1.728	.937	.696	.85-03

HYPERGOLIC STREAM IMPINGMENT DATA COMPLIATION

INVESTIGATOR ZUNG*

A L R C MODEL CORRELATION PARAMETERS

FUEL TYPE	TEST NO.	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	COMMENTS	*	PD	IS	P (IN)	EM	SPR	DV (SEC)
N2H4	15	.027	.027	100.	60.	14.7	23.0	35.0	70.0	70.0	.940	1.620	SEP	*	544.4	.037	.543	.893	1.612	.64-04
N2H4	28	.027	.027	100.	60.	14.7	44.0	75.0	70.0	70.0	.840	2.050	SEP	*	544.4	.017	.543	.784	2.023	.30-04
N2H4	58	.027	.027	100.	60.	14.7	55.0	46.0	69.0	69.0	1.780	.470	MIX	*	544.4	.026	.543	.776	.487	.49-04
N2H4	61	.027	.027	100.	60.	14.7	42.0	40.0	70.0	70.0	1.500	.640	SEP	*	544.4	.033	.543	.901	.632	.56-04
N2H4	63	.027	.027	100.	60.	14.7	41.0	52.0	67.0	70.0	1.140	1.100	MIX	*	544.4	.025	.543	.994	1.117	.43-04
N2H4	64	.027	.027	100.	60.	14.7	45.0	53.0	65.0	58.0	1.210	1.020	MIX	*	544.4	.021	.543	.999	.963	.42-04
N2H4	68	.027	.027	100.	60.	14.7	71.0	78.0	70.0	70.0	1.290	.860	SEP	*	544.4	.017	.543	.985	.840	.29-04
N2H4	79	.027	.027	100.	60.	14.7	20.0	25.0	70.0	70.0	1.110	1.160	SEP	*	544.4	.052	.543	.996	1.088	.90-04
N2H4	80	.027	.027	100.	60.	14.7	41.0	54.0	68.0	68.0	1.090	1.220	MIX	*	544.4	.021	.543	.982	1.207	.42-04
N2H4	81	.027	.027	100.	60.	14.7	34.0	53.0	70.0	70.0	.910	1.750	SEP	*	544.4	.025	.543	.872	1.692	.42-04
N2H4	82	.027	.027	100.	60.	14.7	40.0	52.0	70.0	70.0	.020	1.700	SEP	*	544.4	.025	.543	.987	1.177	.43-04
N2H4	83	.027	.027	100.	60.	14.7	41.0	52.0	70.0	70.0	1.080	1.200	SEP	*	544.4	.025	.543	.994	1.120	.43-04
N2H4	85	.027	.027	100.	60.	14.7	38.0	48.0	70.0	70.0	1.020	1.080	SEP	*	544.4	.027	.543	.994	1.111	.47-04
N2H4	89	.027	.027	100.	60.	14.7	19.0	24.0	67.0	68.0	1.100	1.180	MIX	*	544.4	.046	.543	.995	1.109	.94-04
N2H4	90	.027	.027	100.	60.	14.7	53.0	94.0	67.0	67.0	.820	2.180	MIX	*	544.4	.011	.543	.742	2.188	.24-04
N2H4	91	.027	.027	100.	60.	14.7	53.0	94.0	70.0	70.0	.820	2.180	SEP	*	544.4	.014	.543	.741	2.190	.24-04
N2H4	92	.027	.027	100.	60.	14.7	65.0	92.0	70.0	70.0	1.020	1.380	SEP	*	544.4	.014	.543	.946	1.395	.24-04
N2H4	93	.027	.027	100.	60.	14.7	43.0	60.0	60.0	60.0	1.040	1.310	MIX	*	544.4	.010	.543	.956	1.351	.37-04
N2H4	94	.027	.027	100.	60.	14.7	39.0	56.0	45.0	45.0	1.310	.630	MIX	*	544.4	.003	.543	.940	1.423	.40-04
N2H4	95	.027	.027	100.	60.	14.7	61.0	67.0	45.0	45.0	1.310	.830	MIX	*	544.4	.003	.543	.983	.832	.34-04
N2H4	96	.027	.027	100.	60.	14.7	22.0	29.0	45.0	45.0	1.080	1.230	MIX	*	544.4	.006	.543	.984	1.199	.78-04
N2H4	98	.027	.027	100.	60.	14.7	23.0	29.0	45.0	45.0	1.110	1.170	MIX	*	544.4	.006	.543	.996	1.097	.78-04
N2H4	99	.027	.027	100.	60.	14.7	40.0	64.0	80.0	80.0	.890	1.800	SEP	*	544.4	.044	.543	.846	1.789	.35-04
N2H4	100	.027	.027	100.	60.	14.7	20.0	33.0	75.0	80.0	.840	2.200	SEP	*	544.4	.085	.543	.818	1.894	.68-04
N2H4	101	.027	.027	100.	60.	14.7	20.0	36.0	79.0	83.0	.800	2.280	SEP	*	544.4	.097	.543	.724	2.259	.62-04
N2H4	102	.027	.027	100.	60.	14.7	18.0	24.0	78.0	82.0	1.100	1.200	UNDEF	*	544.4	.135	.543	.977	1.239	.94-04
N2H4	108	.027	.027	100.	60.	14.7	47.0	36.0	70.0	95.0	1.890	.410	SEP	*	544.4	.231	.543	.671	.403	.62-04
N2H4	109	.027	.027	100.	60.	14.7	42.0	30.0	70.0	95.0	2.010	.410	SEP	*	544.4	.277	.543	.591	.351	.75-04
N2H4	110	.027	.027	100.	60.	14.7	25.0	31.0	70.0	95.0	1.180	1.060	SEP	*	544.4	.268	.543	.998	1.057	.73-04
N2H4	111	.027	.027	100.	60.	14.7	23.0	24.0	65.0	65.0	1.380	.760	MIX	*	544.4	.037	.543	.962	.757	.94-04
N2H4	112	.027	.027	100.	60.	14.7	27.0	33.0	65.0	65.0	1.160	1.070	MIX	*	544.4	.027	.543	.999	1.038	.68-04
N2H4	113	.027	.027	100.	60.	14.7	24.0	33.0	70.0	110.0	1.040	1.330	SEP	*	544.4	.708	.543	.968	1.290	.68-04
N2H4	114	.027	.027	100.	60.	14.7	18.0	27.0	70.0	105.0	.960	1.590	SEP	*	544.4	.617	.543	.912	1.539	.83-04
N2H4	116	.027	.027	100.	60.	14.7	18.0	22.0	70.0	105.0	.960	1.580	UNDEF	*	544.4	.757	.543	1.000	1.022	.10-03
N2H4	117	.027	.027	100.	60.	14.7	16.0	25.0	70.0	80.0	.960	1.580	UNDEF	*	544.4	.112	.543	.872	1.691	.90-04
N2H4	118	.060	.060	100.	60.	14.7	52.0	70.0	70.0	80.0	1.070	1.280	UNDEF	*	245.0	.089	1.206	.975	1.255	.71-04
N2H4	119	.060	.060	100.	60.	14.7	14.0	17.0	70.0	80.0	1.230	.950	SEP	*	245.0	.365	1.206	1.000	1.022	.29-03
N2H4	120	.060	.060	100.	60.	14.7	17.0	22.0	70.0	80.0	1.120	1.150	UNDEF	*	245.0	.282	1.206	.989	1.160	.23-03
N2H4	121	.060	.060	100.	60.	14.7	36.0	48.0	70.0	80.0	1.090	1.210	UNDEF	*	245.0	.129	1.206	.979	1.232	.10-03
N2H4	122	.060	.060	100.	60.	14.7	68.0	93.0	70.0	80.0	1.060	1.280	UNDEF	*	245.0	.067	1.206	.967	1.296	.54-04

*Ref. 27

HYPERGOLIC STREAM IMPINGMENT DATA COMPLIATION

INVESTIGATOR ZUNG

A L R C MODEL CORRELATION PARAMETERS

FUEL TYPE	TEST NO.	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	COMMENTS	*	PD	IS	R (IN)	EM	SPR	DV (SEC)
N2H4	123	.060	.060	100.	60.	14.7	13.0	18.0	75.0	75.0	1.160	1.060	SEP	*	245.0	.236	1.206	.959	1.337	.28-03
N2H4	124	.060	.060	100.	60.	14.7	8.3	13.0	71.0	72.0	.950	1.060	SEP	*	245.0	.260	1.206	.868	1.708	.38-03
N2H4	125	.060	.060	100.	60.	14.7	6.6	11.0	71.0	72.0	.890	1.810	SEP	*	245.0	.307	1.206	.808	1.934	.45-03
N2H4	126	.060	.060	100.	60.	14.7	5.4	8.6	72.0	72.0	.900	1.770	SEP	*	245.0	.393	1.206	.852	1.767	.58-03
N2H4	127	.060	.060	100.	60.	14.7	4.3	5.6	72.0	72.0	1.100	1.170	SEP	*	245.0	.603	1.206	.986	1.182	.89-03
N2H4	128	.060	.060	100.	60.	14.7	13.0	16.0	40.0	50.0	1.110	1.150	POP	*	245.0	.036	1.206	.999	1.038	.31-03
N2H4	129	.060	.060	100.	60.	14.7	9.1	14.0	42.0	52.0	.960	1.560	POP	*	245.0	.049	1.206	.890	1.623	.36-03
N2H4	130	.060	.060	100.	60.	14.7	8.3	10.0	42.0	52.0	1.180	1.010	POP	*	245.0	.068	1.206	1.000	.996	.50-03
N2H4	131	.060	.060	100.	60.	14.7	8.0	9.0	42.0	52.0	1.270	.880	POP	*	245.0	.076	1.206	.990	.868	.56-03
N2H4	132	.060	.060	100.	60.	14.7	10.0	7.9	45.0	52.0	1.830	.430	POP	*	245.0	.086	1.206	.706	.429	.63-03
N2H4	133	.060	.060	100.	60.	14.7	9.9	12.0	45.0	50.0	1.180	1.000	POP	*	245.0	.049	1.206	1.000	1.011	.[illegible]-03
N2H4	134	.060	.060	100.	60.	14.7	9.3	13.0	47.0	50.0	1.000	1.420	POP	*	245.0	.044	1.206	.957	1.347	.38-03
N2H4	135	.060	.060	100.	60.	14.7	4.3	8.6	63.0	62.0	.710	2.810	POP	*	245.0	.179	1.206	.606	2.779	.58-03
N2H4	136	.060	.060	100.	60.	14.7	12.0	14.0	54.0	54.0	1.170	1.050	POP	*	245.0	.057	1.206	.998	.942	.36-03
N2H4	137	.060	.060	100.	60.	14.7	8.2	12.0	55.0	55.0	1.040	1.540	POP	*	245.0	.073	1.206	.926	1.483	.42-03
N2H4	139	.060	.060	100.	60.	14.7	9.6	12.0	61.0	61.0	1.130	1.110	POP	*	245.0	.119	1.206	.997	1.084	.42-03
N2H4	140	.060	.050	100.	60.	14.7	14.0	20.0	63.0	63.0	.980	1.470	POP	*	245.0	.083	1.206	.941	1.417	.25-03
N2H4	141	.040	.040	100.	60.	14.7	22.0	26.0	66.0	70.0	1.200	.990	POP	*	367.5	.074	.804	1.000	.969	.13-03
N2H4	142	.040	.040	100.	60.	14.7	18.0	21.0	70.0	70.0	1.220	.950	SEP	*	367.5	.092	.804	.999	.948	.16-03
N2H4	143	.040	.040	100.	60.	14.7	13.0	17.0	70.0	70.0	1.070	1.250	SEP	*	367.5	.114	.804	.985	1.191	.20-03
N2H4	144	.040	.040	100.	60.	14.7	12.0	14.0	70.0	70.0	1.180	1.030	SEP	*	367.5	.138	.804	.999	.948	.24-03
N2H4	148	.040	.040	100.	60.	14.7	21.0	17.0	72.0	92.0	1.710	.490	SEP	*	367.5	.585	.804	.736	.452	.20-03
N2H4	149	.040	.040	100.	60.	14.7	24.0	28.0	68.0	68.0	1.210	.970	MIX	*	367.5	.059	.804	.999	.947	.12-03
N2H4	150	.040	.040	100.	60.	14.7	24.0	28.0	67.0	59.0	1.200	.980	POP	*	367.5	.029	.804	.999	.950	.12-03
N2H4	151	.040	.040	100.	60.	14.7	16.0	19.0	62.0	65.0	1.220	1.290	POP	*	367.5	.069	.804	1.000	.978	.18-03
N2H4	152	.040	.040	100.	60.	14.7	14.0	19.0	63.0	63.0	1.010	1.400	MIX	*	367.5	.059	.804	.970	1.279	.18-03
N2H4	164	.040	.040	100.	60.	149.0	16.0	22.0	69.0	73.0	1.070	1.250	MIX	*	3725.0	.111	.372	.964	1.313	.15-03
N2H4	165	.040	.040	100.	60.	189.0	23.0	23.0	67.0	73.0	1.440	.690	MIX	*	4725.0	.106	.344	.936	.693	.14-03
N2H4	166	.040	.040	100.	60.	187.0	24.0	23.0	66.0	73.0	1.470	.650	MIX	*	4675.0	.106	.345	.904	.636	.14-03
N2H4	167	.040	.040	100.	60.	189.0	23.0	25.0	47.0	59.0	1.350	.790	MIX	*	4725.0	.032	.344	.978	.811	.13-03
N2H4	169	.040	.040	100.	60.	209.0	24.0	27.0	40.0	52.0	1.310	.840	UNDEF	*	5225.0	.017	.332	.990	.867	.12-03
N2H4	170	.040	.040	100.	60.	111.0	15.0	15.0	40.0	58.0	1.450	.680	MIX	*	2775.0	.050	.410	.930	.683	.22-03
N2H4	171	.040	.040	100.	60.	191.0	23.0	27.0	43.0	58.0	1.250	.920	MIX	*	4775.0	.028	.342	.998	.943	.12-03
N2H4	174	.040	.040	100.	60.	172.0	22.0	27.0	54.0	64.0	1.200	.990	MIX	*	4300.0	.045	.354	.999	1.038	.12-03
N2H4	175	.040	.040	100.	60.	187.0	22.0	27.0	57.0	65.0	1.200	.990	MIX	*	4675.0	.048	.345	.999	1.040	.12-03
N2H4	179	.040	.040	100.	60.	163.0	21.0	23.0	56.0	63.0	1.300	.840	MIX	*	4075.0	.048	.361	.982	.828	.14-03
N2H4	180	.040	.040	100.	60.	165.0	19.0	24.0	76.0	81.0	1.550	1.070	MIX	*	4125.0	.186	.359	.995	1.111	.14-03
N2H4	181	.040	.040	100.	60.	140.0	18.0	20.0	77.0	82.0	1.230	.940	MIX	*	3500.0	.240	.380	.989	.860	.17-03
N2H4	182	.040	.040	100.	60.	259.0	20.0	19.0	81.0	87.0	1.470	.660	UNDEF	*	6475.0	.365	.309	.899	.629	.18-03
N2H4	183	.040	.040	100.	60.	157.0	19.0	29.0	85.0	93.0	.940	1.610	MIX	*	3925.0	.368	.365	.890	1.625	.11-03

HYPERGOLIC STREAM IMPINGMENT DATA COMPLIATION

INVESTIGATOR ZUNG

A L R C MODEL CORRELATION PARAMETERS

FUEL TYPE	TEST NO.	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	COMMENTS	*	PO	IS	P (IN)	EM	SPR	DV (SEC)
N2H4	184	.040	.040	100.	60.	119.0	17.0	14.0	95.0	101.0	1.830	.430	MIX	*	2975.0	1.338	.401	.763	.475	.24-03
N2H4	185	.040	.040	100.	60.	131.0	17.0	17.0	107.0	96.0	1.410	.720	MIX	*	3275.0	.777	.388	.943	.710	.20-03
N2H4	186	.040	.040	100.	60.	155.0	22.0	24.0	77.0	91.0	1.310	.840	MIX	*	3875.0	.386	.367	.982	.825	.14-03
N2H4	187	.040	.040	100.	60.	194.0	27.0	27.0	91.0	91.0	1.410	.720	MIX	*	4850.0	.343	.341	.940	.702	.12-03
N2H4	188	.040	.040	100.	60.	194.0	26.0	29.0	86.0	90.0	1.240	.920	MIX	*	4850.0	.297	.341	.990	.870	.11-03
N2H4	191	.040	.040	100.	60.	170.0	25.0	25.0	96.0	103.0	1.420	.710	MIX	*	4250.0	.860	.356	.939	.701	.13-03
N2H4	192	.040	.040	100.	60.	152.0	24.0	27.0	104.0	113.0	1.270	.890	MIX	*	3800.0	1.566	.369	.993	.889	.12-03
N2H4	193	.040	.040	100.	60.	174.0	25.0	31.0	94.0	99.0	1.140	1.100	MIX	*	4350.0	.526	.353	.997	1.078	.11-03
N2H4	194	.040	.040	100.	60.	169.0	24.0	30.0	100.0	104	1.130	1.120	MIX	*	4225.0	.769	.357	.996	1.098	.11-03
N2H4	196	.040	.040	100.	60.	194.0	24.0	32.0	76.0	94.0	1.090	1.210	MIX	*	4850.0	.358	.341	.979	1.229	.10-03
N2H4	197	.040	.040	100.	60.	187.0	16.0	32.0	106.0	76.0	.720	2.790	MIX	*	4675.0	.096	.345	.588	2.866	.10-03
N2H4	198	.040	.040	100.	60.	164.0	24.0	27.0	91.0	101.0	1.250	.920	MIX	*	4100.0	.694	.360	.992	.884	.12-03
N2H4	199	.040	.040	100.	60.	181.0	23.0	32.0	93.0	108.0	1.030	1.360	MIX	*	4525.0	.945	.349	.956	1.349	.10-03
N2H4	200	.040	.040	100.	60.	203.0	23.0	32.0	64.0	77.0	1.040	1.320	MIX	*	5075.0	.103	.335	.959	1.336	.10-03
N2H4	201	.040	.040	100.	60.	178.0	20.0	32.0	62.0	77.0	.920	1.680	MIX	*	4450.0	.103	.350	.853	1.764	.10-03
N2H4	204	.040	.040	100.	60.	110.0	31.0	36.0	52.0	64.0	1.230	.950	MIX	*	2750.0	.033	.411	.997	.927	.93-04
N2H4	205	.040	.040	100.	60.	115.0	33.0	35.0	76.0	84.0	1.360	1.360	MIX	*	2875.0	.159	.405	.970	.782	.95-04
N2H4	206	.040	.040	100.	60.	115.0	33.0	30.0	91.0	95.0	1.590	1.590	MIX	*	2875.0	.410	.405	.863	.579	.11-03
N2H4	207	.040	.040	100.	60.	110.0	29.0	34.0	110.0	107.0	1.230	1.230	MIX	*	2750.0	.831	.411	1.000	.973	.98-04
N2H4	208	.040	.040	100.	60.	110.0	28.0	40.0	102.0	108.0	.990	1.440	MIX	*	2750.0	.756	.411	.937	1.434	.83-04
N2H4	209	.040	.040	100.	60.	110.0	29.0	35.0	105.0	110.0	1.190	.990	MIX	*	2750.0	.989	.411	1.000	1.025	.95-04
N2H4	210	.040	.040	100.	60.	110.0	29.0	37.0	121.0	110.0	1.120	1.130	MIX	*	2750.0	.935	.411	.989	1.162	.90-04
N2H4	211	.040	.040	100.	60.	110.0	30.0	35.0	121.0	116.0	1.240	.930	MIX	*	2750.0	1.472	.411	.999	.969	.95-04
N2H4	212	.040	.040	100.	60.	110.0	30.0	35.0	121.0	118.0	1.240	.930	MIX	*	2750.0	1.678	.411	.999	.969	.95-04
N2H4	215	.040	.040	100.	60.	110.0	56.0	68.0	108.0	118.0	1.170	.850	MIX	*	2750.0	.864	.411	.999	1.036	.49-04
N2H4	217	.040	.040	100.	60.	110.0	56.0	68.0	93.0	101.0	1.170	.850	MIX	*	2750.0	.275	.411	1.000	1.031	.49-04
N2H4	219	.040	.040	100.	60.	110.0	56.0	63.0	123.0	121.0	1.270	.790	MIX	*	2750.0	1.133	.411	.994	.900	.53-04
N2H4	220	.040	.040	100.	60.	110.0	54.0	68.0	117.0	122.0	1.130	.880	MIX	*	2750.0	1.119	.411	.993	1.121	.49-04
N2H4	221	.040	.040	100.	60.	110.0	59.0	68.0	103.0	110.0	1.240	.810	MIX	*	2750.0	.509	.411	.998	.933	.49-04
N2H4	222	.030	.040	100.	60.	110.0	55.0	68.0	119.0	114.0	1.160	.860	MIX	*	2750.0	.664	.411	.997	1.087	.49-04
N2H4	223	.040	.040	100.	60.	110.0	59.0	68.0	119.0	114.0	1.520	.800	UNDEF	*	2750.0	.664	.411	.998	.945	.49-04
N2H4	231	.040	.040	100.	60.	350.0	51.0	66.0	79.0	67.0	1.100	1.180	SEP	*	8750.0	.023	.280	.987	1.177	.51-04
N2H4	232	.040	.040	100.	60.	380.0	55.0	66.0	85.0	72.0	1.180	1.000	SEP	*	9500.0	.034	.272	1.000	1.015	.51-04
N2H4	234	.040	.040	100.	60.	353.0	68.0	68.0	118.0	118.0	1.120	.880	SEP	*	8825.0	.864	.279	.943	.709	.49-04
N2H4	235	.040	.040	100.	60.	353.0	50.0	68.0	84.0	103.0	1.050	.950	SEP	*	8825.0	.316	.279	.970	1.282	.49-04
N2H4	236	.040	.040	100.	60.	346.0	48.0	63.0	71.0	90.0	1.080	.920	SEP	*	8650.0	.137	.281	.985	1.189	.53-04
N2H4	237	.040	.040	100.	60.	362.0	56.0	68.0	63.0	93.0	1.180	.840	SEP	*	9050.0	.157	.277	1.000	1.009	.49-04
N2H4	238	.040	.040	100.	60.	361.0	50.0	68.0	66.0	85.0	1.050	.950	SEP	*	9025.0	.088	.277	.971	1.274	.49-04
N2H4	239	.040	.040	100.	60.	145.0	22.0	27.0	72.0	82.0	1.190	1.000	MIX	*	3625.0	.178	.375	.999	1.044	.12-03
N2H4	240	.040	.040	100.	60.	238.0	65.0	68.0	63.0	67.0	1.370	.760	UNDEF	*	5950.0	.022	.318	.963	.759	.49-04

HYPERGOLIC STREAM IMPINGMENT DATA COMPLIATION

INVESTIGATOR ZUNG

A L R C MODEL CORRELATION PARAMETERS

FUEL TYPE	TEST NO.	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	COMMENTS	*	Pn	IS	P (IN)	EM	SPR	DV (SEC)
N2H4	241	.040	.040	100.	60.	230.0	74.0	68.0	115.0	117.0	1.560	.590	MIX	*	5750.0	.809	.322	.877	.597	.49-04
N2H4	242	.040	.040	100.	60.	176.0	55.0	69.0	146.0	127.0	1.140	1.110	MIX	*	4400.0	1.518	.352	.991	1.140	.48-04
N2H4	243	.040	.040	100.	60.	176.0	55.0	69.0	117.0	122.0	1.140	1.110	MIX	*	4400.0	1.103	.352	.994	1.113	.48-04
N2H4	244	.040	.040	100.	60.	338.0	39.0	65.0	44.0	54.0	.870	1.890	SEP	*	8450.0	.008	.283	.815	1.907	.51-04
N2H4	246	.040	.040	100.	60.	400.0	57.0	61.0	39.0	41.0	1.310	.820	SEP	*	10000.0	.003	.268	.972	.788	.55-04
N2H4	247	.040	.040	100.	60.	215.0	58.0	66.0	51.0	62.0	1.250	.920	MIX	*	5375.0	.016	.329	.993	.891	.51-04
N2H4	248	.040	.040	100.	60.	115.0	61.0	65.0	51.0	60.0	1.340	.790	MIX	*	2875.0	.013	.405	.970	.782	.51-04
N2H4	250	.040	.040	100.	60.	218.0	61.0	68.0	58.0	70.0	1.290	.890	MIX	*	5450.0	.028	.328	.988	.856	.49-04
N2H4	251	.040	.040	100.	60.	384.0	56.0	65.0	62.0	74.0	1.230	.940	SEP	*	9600.0	.040	.271	.997	.930	.51-04
N2H4	252	.040	.040	100.	60.	307.0	45.0	50.0	65.0	76.0	1.280	.870	UNDEF	*	7675.0	.061	.292	.988	.853	.67-04
N2H4	253	.040	.040	100.	60.	507.0	35.0	38.0	68.0	77.0	1.290	.850	SEP	*	12675.0	.087	.247	.980	.816	.88-04
N2H4	254	.040	.040	100.	60.	520.0	36.0	28.0	77.0	86.0	1.330	.590	SEP	*	13000.0	.230	.245	.695	.420	.12-03
N2H4	255	.040	.040	100.	60.	84.0	49.0	52.0	106.0	103.0	1.320	.820	MIX	*	2100.0	.414	.450	.974	.796	.64-04
N2H4	256	.040	.040	100.	60.	100.0	56.0	65.0	126.0	120.0	1.260	.920	MIX	*	2500.0	1.029	.425	.999	.961	.51-04
N2H4	257	.040	.040	100.	60.	122.0	56.0	66.0	124.0	120.0	1.200	.980	MIX	*	3050.0	1.014	.397	1.000	.989	.51-04
N2H4	258	.040	.040	100.	60.	423.0	32.0	37.0	93.0	104.0	1.220	.950	SEP	*	10575.0	.623	.263	.998	.934	.90-04
N2H4	259	.040	.040	100.	60.	461.0	32.0	37.0	94.0	99.0	1.220	.840	SEP	*	11525.0	.441	.255	.998	.937	.90-04
N2H4	260	.040	.040	100.	60.	461.0	32.0	37.0	74.0	84.0	1.240	.920	SEP	*	11525.0	.150	.255	.997	.928	.90-04
N2H4	261	.040	.040	100.	60.	115.0	31.0	37.0	79.0	88.0	1.180	1.010	MIX	*	2875.0	.201	.405	1.000	.991	.90-04
N2H4	262	.040	.040	100.	60.	130.0	34.0	41.0	92.0	97.0	1.180	1.040	MIX	*	3250.0	.346	.389	1.000	1.018	.81-04
N2H4	263	.040	.040	100.	60.	149.0	40.0	52.0	90.0	97.0	1.100	1.180	MIX	*	3725.0	.273	.372	.986	1.181	.64-04
N2H4	264	.040	.040	100.	60.	169.0	46.0	53.0	90.0	97.0	1.240	.930	MIX	*	4225.0	.267	.357	.997	.928	.63-04
N2H4	265	.040	.040	100.	60.	188.0	51.0	61.0	84.0	93.0	1.170	1.030	MIX	*	4700.0	.175	.344	1.000	.997	.55-04
N2H4	266	.040	.040	100.	60.	203.0	56.0	69.0	83.0	93.0	1.160	.860	MIX	*	5075.0	.155	.335	.998	1.057	.48-04
N2H4	267	.040	.040	100.	60.	388.0	58.0	68.0	81.0	88.0	1.220	.950	SEP	*	9700.0	.110	.270	.999	.958	.49-04
N2H4	268	.040	.040	100.	60.	381.0	58.0	57.0	78.0	86.0	1.440	.680	SEP	*	9525.0	.113	.272	.924	.672	.58-04
N2H4	269	.040	.040	100.	60.	353.0	55.0	52.0	77.0	86.0	1.490	.570	SEP	*	8825.0	.124	.279	.894	.621	.64-04
N2H4	270	.040	.040	100.	60.	176.0	49.0	71.0	138.0	129.0	.970	1.520	MIX	*	4400.0	1.673	.352	.920	1.508	.47-04
N2H4	272	.040	.040	100.	60.	179.0	56.0	63.0	106.0	111.0	1.280	.870	MIX	*	4475.0	.587	.350	.993	.891	.53-04
N2H4	273	.040	.040	100.	60.	176.0	58.0	63.0	120.0	124.0	1.310	.820	MIX	*	4400.0	1.374	.352	.984	.836	.53-04
N2H4	274	.040	.040	100.	60.	176.0	55.0	46.0	117.0	120.0	1.700	.490	MIX	*	4400.0	1.454	.352	.785	.495	.72-04
N2H4	275	.040	.040	100.	60.	138.0	42.0	51.0	114.0	117.0	1.170	1.030	MIX	*	3450.0	1.079	.381	.999	1.042	.65-04
N2H4	276	.040	.040	100.	60.	279.0	75.0	73.0	70.0	70.0	1.450	.680	UNDEF	*	6975.0	.026	.302	.918	.660	.46-04
N2H4	278	.040	.040	100.	60.	237.0	61.0	73.0	70.0	70.0	1.190	.980	MIX	*	5925.0	.026	.319	1.000	.997	.46-04
N2H4	279	.040	.040	100.	60.	250.0	66.0	73.0	70.0	70.0	1.290	1.160	MIX	*	6250.0	.026	.313	.987	.852	.46-04
N2H4	281	.040	.040	100.	60.	100.0	101.0	127.0	69.0	74.0	1.130	1.120	MIX	*	2500.0	.021	.425	.996	1.098	.26-04
N2H4	282	.040	.040	100.	60.	115.0	117.0	127.0	69.0	73.0	1.540	.870	MIX	*	2875.0	.019	.405	.980	.918	.26-04
N2H4	283	.040	.040	100.	60.	326.0	84.0	98.0	84.	98.0	1.220	.940	SEP	*	8150.0	.155	.296	.998	.946	.34-04
N2H4	284	.040	.040	100.	60.	282.0	76.0	93.0	54.0	74.0	1.160	1.060	SEP	*	7050.0	.023	.301	1.000	1.026	.36-04
N2H4	285	.040	.040	100.	60.	228.0	63.0	78.0	54.0	86.0	1.160	1.060	MIX	*	5700.0	.083	.323	.999	1.044	.43-04

HYPERGOLIC STREAM IMPINGMENT DATA COMPLIATION

INVESTIGATOR ZUNG

A L R C MODEL CORRELATION PARAMETERS

FUEL TYPE	TEST NO.	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	[illegible] (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	COMMENTS	*	PO	IS	R (IN)	EM	SPR	DV (SEC)
N2H4	286	.040	.040	100.	60.	192.0	51.0	63.0	54.0	86.0	1.140	1.060	MIX	*	4800.0	.102	.342	.999	1.040	.53-04
N2H4	287	.040	.040	100.	60.	182.0	44.0	51.0	55.0	86.0	1.250	.920	MIX	*	4550.0	.126	.348	.996	.916	.65-04
N2H4	288	.040	.040	100.	60.	186.0	46.0	52.0	62.0	57.0	1.890	.600	MIX	*	4650.0	.013	.345	.993	.889	.64-04
N2H4	289	.040	.040	100.	60.	174.0	49.0	53.0	62.0	55.0	1.320	.820	MIX	*	4350.0	.011	.353	.979	.815	.63-04
N2H4	290	.040	.040	100.	60.	186.0	54.0	56.0	96.0	101.0	1.030	.780	MIX	*	4650.0	.335	.345	.961	.754	.60-04
N2H4	291	.040	.040	100.	60.	162.0	44.0	54.0	106.0	71.0	1.130	1.090	MIX	*	4050.0	.039	.362	.997	1.082	.62-04
N2H4	293	.060	.060	100.	60.	362.0	92.0	121.0	60.0	62.0	1.090	1.200	SEP	*	6033.3	.013	.415	.984	1.199	.41-04
N2H4	294	.060	.060	100.	60.	180.0	46.0	54.0	60.0	64.0	1.240	.940	MIX	*	3000.0	.033	.524	.999	.954	.93-04
N2H4	295	.060	.060	100.	60.	14.7	64.0	73.0	59.0	53.0	1.440	.780	POP	*	245.0	.010	1.206	.995	.905	.68-04
N2H4	296	.060	.060	100.	60.	14.7	49.0	61.0	57.0	54.0	1.150	1.090	POP	*	245.0	.013	1.206	.997	1.076	.82-04
N2H4	297	.060	.060	100.	60.	68.0	49.0	61.0	57.0	55.0	1.230	1.010	POP	*	1133.3	.014	.724	.997	1.075	.82-04
N2H4	298	.040	.040	100.	60.	76.0	46.0	53.0	52.0	41.0	1.200	.960	MIX	*	1900.0	.003	.465	.997	.923	.63-04
N2H4	299	.040	.040	100.	60.	106.0	36.0	53.0	53.0	40.0	.930	1.590	MIX	*	2650.0	.003	.416	.919	1.509	.63-04
N2H4	300	.040	.040	100.	60.	122.0	46.0	37.0	53.0	41.0	1.110	1.050	MIX	*	3050.0	.005	.397	.733	.450	.90-04
N2H4	301	.040	.040	100.	60.	100.0	47.0	57.0	53.0	41.0	1.160	1.050	MIX	*	2500.0	[illegible]	.425	1.000	1.024	.58-04
N2H4	302	.040	.040	100.	60.	192.0	36.0	57.0	55.0	43.0	1.070	1.740	MIX	*	4800.0	.004	.342	.858	1.746	.58-04
N2H4	304	.040	.040	100.	60.	14.7	29.0	42.0	37.0	37.0	1.040	1.410	POP	*	367.5	.003	[illegible]	.935	1.443	.79-04
N2H4	305	.040	.040	100.	60.	14.7	13.0	16.0	43.0	42.0	1.000	1.270	MIX	*	367.5	.012	.804	.999	1.045	.21-03
N2H4	306	.040	.040	100.	60.	14.7	16.0	16.0	39.0	44.0	1.260	.800	POP	*	367.5	.014	.804	.932	.687	.21-03
N2H4	307	.040	.040	100.	60.	14.7	52.0	49.0	32.0	32.0	1.580	.590	MIX	*	367.5	.002	[illegible]	.886	.610	.58-04
N2H4	308	.040	.040	100.	60.	14.7	49.0	55.0	58.0	59.0	1.300	.860	POP	*	367.5	.015	.804	.991	.873	.61-04
N2H4	309	.040	.040	100.	60.	14.7	58.0	66.0	58.0	59.0	1.250	.860	POP	*	367.5	.012	.804	.994	.897	.51-04
N2H4	310	.040	.040	100.	60.	14.7	58.0	68.0	70.0	78.0	1.250	1.170	MIX	*	367.5	.052	.804	.999	.953	.49-04
N2H4	311	.040	.040	100.	60.	14.7	58.0	68.0	60.0	66.0	1.250	1.170	MIX	*	367.5	.021	.804	.999	.951	.49-04
N2H4	312	.040	.040	100.	60.	14.7	64.0	68.0	66.0	61.0	1.250	.800	MIX	*	367.5	.014	.804	.972	.787	.49-04
N2H4	313	.040	.040	100.	60.	14.7	64.0	68.0	53.0	55.0	1.250	.800	MIX	*	367.5	.009	.804	.970	.780	.49-04
N2H4	314	.040	.040	100.	60.	14.7	63.0	68.0	53.0	55.0	1.290	.800	MIX	*	367.5	.009	.804	.977	.805	.49-04
N2H4	316	.040	.040	100.	60.	14.7	63.0	63.0	48.0	51.0	1.440	.700	MIX	*	367.5	.007	.804	.934	.670	.53-04
N2H4	317	.040	.040	100	60.	14.7	54.0	55.0	45.0	51.0	1.450	.710	POP	*	367.5	.008	.804	.945	.714	.61-04
N2H4	318	.040	.040	100.	60.	14.7	23.0	28.0	48.0	51.0	1.150	1.070	SEP	*	367.5	.015	.804	1.000	1.022	.12-03
N2H4	319	.040	.040	100.	60.	14.7	27.0	28.0	45.0	51.0	1.360	.770	SEP	*	367.5	.015	.804	.956	.740	.12-03
N2H4	320	.040	.040	100.	60.	14.7	18.0	19.0	55.0	55.0	1.400	.760	POP	*	367.5	.031	.804	.967	.772	.18-03
N2H4	321	.040	.040	100.	60.	14.7	16.0	19.0	57.0	59.0	1.400	.760	POP	*	367.5	.042	.804	.967	.771	.18-03
N2H4	322	.040	.040	100.	60.	14.7	18.0	19.0	58.0	61.0	1.290	.820	MIX	*	367.5	.050	.804	.967	.771	.18-03
N2H4	323	[illegible]	.040	100.	60.	14.7	19.0	19.0	50.0	51.0	1.460	.700	POP	*	367.5	.022	.804	.934	.691	.18-03
N2H4	324	.040	.040	100.	60.	14.7	18.0	18.0	50.0	51.0	1.570	.620	SEP	*	367.5	.023	.804	.934	.691	.19-03
N2H4	325	.040	.040	100.	60.	14.7	23.0	24.0	63.0	72.0	1.370	.780	SEP	*	367.5	.094	.804	.961	.733	.14-03
N2H4	326	.060	.060	100.	60.	14.7	22.0	24.0	58.0	51.0	1.300	.850	POP	*	245.0	.026	1.206	.982	.828	.21-03
N2H4	327	.060	.060	100.	60.	14.7	21.0	23.0	48.0	48.0	1.300	.840	POP	*	245.0	.021	1.206	.983	.829	.22-03
N2H4	328	.060	.060	100.	60.	14.7	22.0	24.0	47.0	55.0	1.310	.830	POP	*	245.0	.036	1.206	.980	.819	.21-03

HYPERGOLIC STREAM IMPINGMENT DATA COMPLIATION

INVESTIGATOR ZUNG

A L R C MODEL CORRELATION PARAMETERS

FUEL TYPE	TEST NO.	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	COMMENTS	*	PD	IS	P (IN)	EM	SPR	DV (SEC)
N2H4	329	.060	.060	100.	60.	14.7	21.0	24.0	47.0	53.0	1.270	.900	POP	*	245.0	.031	1.206	.994	.899	.21-03
N2H4	330	.060	.060	100.	60.	14.7	21.0	24.0	48.0	53.0	1.270	.900	POP	*	245.0	.031	1.206	.994	.900	.21-03
N2H4	331	.060	.060	100.	60.	14.7	27.0	31.0	64.0	61.0	1.240	.920	POP	*	245.0	.046	1.206	.996	.917	.16-03
N2H4	332	.060	.060	100.	60.	75.0	34.0	43.0	63.0	64.0	1.110	1.160	POP	*	1250.0	.042	.701	.995	1.110	.12-03
N2H4	333	.060	.060	100.	60.	80.0	40.0	50.0	63.0	64.0	1.130	1.120	POP	*	1333.3	.036	.686	.997	1.085	.10-03
N2H4	334	.060	.060	100.	60.	95.0	34.0	57.0	61.0	63.0	.820	2.080	POP	*	1583.3	.029	.648	.804	1.949	.88-04
N2H4	335	.060	.060	100.	60.	96.0	26.0	31.0	64.0	61.0	1.230	1.570	POP	*	1600.0	.046	.646	1.000	.989	.16-03
N2H4	336	.060	.060	100.	60.	70.0	34.0	44.0	63.0	64.0	1.110	1.150	POP	*	1166.7	.041	.717	.989	1.163	.11-03
N2H4	337	.060	.060	100.	60.	80.0	36.0	57.0	61.0	66.0	.890	1.780	POP	*	1333.3	.037	.686	.861	1.736	.88-04
N2H4	338	.060	.060	100.	60.	85.0	43.0	50.0	86.0	89.0	1.240	.940	POP	*	1416.7	.240	.672	.998	.946	.10-03
N2H4	339	.060	.060	100.	60.	125.0	45.0	58.0	108.0	97.0	1.110	1.160	POP	*	2083.3	.366	.591	.986	1.180	.86-04
N2H4	340	.060	.060	100.	60.	75.0	36.0	50.0	108.0	117.0	1.050	1.310	POP	*	1250.0	1.651	.701	.955	1.356	.10-03
N2H4	341	.060	.060	100.	60.	75.0	41.0	50.0	100.0	107.0	1.160	1.060	POP	*	1250.0	.848	.701	.999	1.044	.10-03
N2H4	342	.060	.060	100.	60.	145.0	42.0	50.0	99.0	107.0	1.210	.990	POP	*	2416.7	.848	.563	1.000	.994	.10-03
N2H4	343	.060	.060	100.	60.	145.0	41.0	50.0	103.0	118.0	1.160	1.060	POP	*	2416.7	1.762	.563	.999	1.041	.10-03
N2H4	344	.060	.060	100.	60.	145.0	43.0	50.0	80.0	81.0	1.240	.810	POP	*	2416.7	.134	.563	.998	.944	.10-03
N2H4	345	.060	.060	100.	60.	165.0	43.0	49.0	78.0	81.0	1.260	.900	POP	*	2750.0	.136	.539	.995	.905	.10-03
N2H4	346	.060	.060	100.	60.	165.0	45.0	50.0	76.0	76.0	1.280	.880	POP	*	2750.0	.092	.539	.989	.862	.10-03
N2H4	347	.060	.060	100.	60.	165.0	44.0	49.0	78.0	80.0	1.250	.920	POP	*	2750.0	.127	.539	.990	.865	.10-03
N2H4	348	.060	.060	100.	60.	165.0	32.0	50.0	83.0	83.0	.910	1.720	POP	*	2750.0	.155	.539	.868	1.708	.10-03
N2H4	349	.060	.060	100.	60.	165.0	33.0	51.0	90.0	91.0	.930	1.640	POP	*	2750.0	.272	.539	.877	1.675	.98-04
N2H4	350	.060	.060	100.	60.	185.0	40.0	51.0	94.0	91.0	1.120	1.130	POP	*	3083.3	.272	.519	.991	1.144	.98-04
N2H4	351	.060	.060	100.	60.	185.0	47.0	50.0	70.0	72.0	1.350	7.820	POP	*	3083.3	.068	.519	.972	.787	.10-03
N2H4	352	.060	.060	100.	60.	165.0	41.0	49.0	68.0	72.0	1.210	.980	UNDEF	*	2750.0	.069	.539	1.000	.992	.10-03
N2H4	353	.060	.060	100.	60.	165.0	42.0	49.0	66.0	70.0	1.230	.938	POP	*	2750.0	.059	.539	.998	.944	.10-03
N2H4	354	.060	.060	100.	60.	165.0	42.0	51.0	50.0	49.0	1.190	1.020	POP	*	2750.0	.010	.539	1.000	1.020	.98-04
N2H4	355	.060	.060	100.	60.	175.0	44.0	51.0	47.0	47.0	1.230	.930	UNDEF	*	2916.7	.009	.529	.997	.928	.98-04
N2H4	356	.060	.060	100.	60.	165.0	36.0	51.0	50.0	49.0	1.030	1.350	POP	*	2750.0	.010	.539	.948	1.388	.98-04
N2H4	357	.060	.060	100.	60.	165.0	41.0	49.0	50.0	51.0	1.210	.970	POP	*	2750.0	.013	.539	1.000	.987	.10-03
N2H4	358	.060	.060	100.	60.	165.0	42.0	51.0	50.0	51.0	1.190	1.020	POP	*	2750.0	.012	.539	1.000	1.019	.98-04
N2H4	359	.060	.060	100.	60.	165.0	42.0	51.0	48.0	47.0	1.190	1.020	POP	*	2750.0	.003	.539	1.000	1.019	.98-04
N2H4	360	.060	.060	100.	60.	165.0	33.0	60.0	57.0	53.0	.079	1.020	POP	*	2750.0	.012	.539	.715	2.295	.83-04
N2H4	361	.060	.060	100.	60.	165.0	42.0	51.0	55.0	55.0	1.020	1.190	POP	*	2750.0	.017	.539	1.000	1.021	.98-04
N2H4	362	.060	.060	100.	60.	105.0	40.0	52.0	55.0	53.0	1.120	1.140	POP	*	1750.0	.014	.627	.988	1.171	.96-04
N2H4	363	.060	.060	100.	60.	105.0	44.0	51.0	53.0	53.0	1.230	.930	POP	*	1750.0	.015	.627	.997	.930	.98-04
N2H4	364	.060	.060	100.	60.	105.0	44.0	52.0	60.0	63.0	1.230	.950	POP	*	1750.0	.032	.627	.999	.968	.96-04
N2H4	365	.060	.060	100.	60.	105.0	43.0	51.0	60.0	63.0	1.220	.960	POP	*	1750.0	.033	.627	1.000	.974	.98-04
N2H4	366	.060	.060	100.	60.	105.0	45.0	52.0	60.0	63.0	1.250	.920	POP	*	1750.0	.032	.627	.997	.925	.96-04
N2H4	367	.060	.060	100.	60.	105.0	45.0	52.0	76.0	80.0	1.250	.930	POP	*	1750.0	.110	.627	.997	.930	.96-04
N2H4	368	.060	.060	100.	60.	185.0	45.0	49.0	68.0	70.0	1.290	.650	POP	*	3083.3	.059	.519	.981	.824	.10-03

HYPERGOLIC STREAM IMPINGMENT DATA COMPLIATION

INVESTIGATOR ZUNG

A L R C MODEL CORRELATION PARAMETFRS

FUEL TYPE	TEST NO.	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	COMMENTS	*	PO	IS	R (IN)	EM	SPR	DV (SEC)
N2H4	369	.060	.060	100.	60.	185.0	43.0	50.0	70.0	69.0	1.240	.930	POP	*	3083.3	.054	.519	.998	.942	.10-03
N2H4	370	.060	.060	100.	60.	185.0	41.0	49.0	65.0	64.0	1.210	.980	POP	*	3083.3	.037	.519	1.000	.993	.10-03
N2H4	371	.060	.060	100.	60.	165.0	37.0	49.0	63.0	63.0	1.060	1.230	POP	*	3083.3	.034	.519	.981	1.218	.10-03
N2H4	372	.060	.060	100.	60.	185.0	34.0	49.0	55.0	55.0	.980	1.450	POP	*	3083.3	.018	.519	.936	1.438	.10-03
N2H4	373	.055	.055	100.	60.	95.0	52.0	60.0	63.0	64.0	1.230	1.030	POP	*	1727.3	.028	.594	.997	.924	.76-04
N2H4	374	.055	.055	100.	60.	95.0	51.0	60.0	63.0	64.0	1.190	.990	POP	*	1727.3	.028	.594	.999	.961	.76-04
N2H4	375	.055	.055	100.	60.	95.0	54.0	60.0	63.0	64.0	1.270	.790	POP	*	1727.3	.028	.594	.988	.857	.76-04
N2H4	376	.055	.055	100.	60.	165.0	54.0	60.0	53.0	64.0	1.290	.850	POP	*	3000.0	.028	.494	.988	.857	.76-04
N2H4	377	.055	.055	100.	60.	175.0	54.0	60.0	65.0	82.0	1.270	.880	POP	*	3181.8	.110	.485	.987	.851	.76-04
N2H4	378	.055	.055	100.	60.	175.0	56.0	61.0	68.0	89.0	1.310	.830	POP	*	3181.8	.181	.485	.980	.817	.75-04
N2H4	379	.055	.055	100.	60.	175.0	55.0	61.0	104.0	82.0	1.290	.860	POP	*	3181.8	.108	.485	.991	.877	.75-04
N2H4	380	.055	.055	100.	60.	175.0	53.0	61.0	114.0	105.0	1.240	.930	POP	*	3181.8	.556	.485	.998	.942	.75-04
N2H4	381	.055	.055	100.	60.	175.0	54.0	61.0	114.0	107.0	1.270	.880	POP	*	3181.8	.637	.485	.995	.907	.75-04
N2H4	382	.055	.055	100.	60.	175.0	52.0	61.0	111.0	110.0	1.210	1.080	POP	*	3181.8	.780	.485	1.000	.974	.75-04
N2H4	383	.055	.055	100.	60.	175.0	56.0	60.0	65.0	66.0	1.320	.810	POP	*	3181.8	.032	.485	.975	.797	.76-04
N2H4	384	.055	.055	100.	60.	175.0	55.0	60.0	88.0	78.0	1.290	.990	POP	*	3181.8	.082	.485	.985	.838	.76-04
N2H4	385	.055	.055	100.	60.	175.0	53.0	60.0	76.0	78.0	1.260	.910	POP	*	3181.8	.082	.485	.994	.893	.76-04
N2H4	388	.055	.055	100.	60.	175.0	42.0	46.0	48.0	51.0	1.290	.848	POP	*	3181.8	.012	.485	.982	.827	.10-03
N2H4	389	.055	.055	100.	60.	175.0	37.0	46.0	48.0	51.0	1.130	1.100	POP	*	3161.8	.012	.485	.998	1.065	.10-03
N2H4	390	.055	.055	100.	60.	175.0	35.0	46.0	48.0	51.0	1.710	.484	POP	*	3181.8	.012	.485	.985	1.191	.10-03
N2H4	391	.055	.055	100.	60.	195.0	49.0	60.0	48.0	52.0	1.170	1.040	POP	*	3545.5	.010	.467	.999	1.034	.76-04
N2H4	392	.055	.055	100.	60.	195.0	49.0	60.0	48.0	52.0	1.160	1.060	POP	*	3545.5	.010	.467	.999	1.034	.76-04
N2H4	393	.055	.055	100.	60.	415.0	37.0	59.0	55.0	60.0	.881	1.840	SEP	*	7545.5	.020	.364	.855	1.756	.78-04
N2H4	394	.060	.060	100.	60.	235.0	61.0	71.0	56.0	62.0	1.210	.967	MIX	*	3916.7	.022	.479	.998	.936	.70-04
N2H4	395	.060	.060	100.	60.	225.0	51.0	71.0	45.0	53.0	1.020	1.370	MIX	*	3750.0	.010	.486	.960	1.332	.70-04
N2H4	396	.060	.060	100.	60.	235.0	60.0	71.0	38.0	45.0	1.200	.991	MIX	*	3916.7	.005	.479	.999	.961	.70-04
N2H4	397	.060	.060	100.	60.	225.0	59.0	71.0	63.0	62.0	1.190	1.520	MIX	*	3750.0	.022	.486	1.000	1.006	.70-04
N2H4	398	.060	.060	100.	60.	235.0	56.0	71.0	71.0	70.0	1.350	.931	MIX	*	3916.7	.041	.479	.994	1.120	.70-04
N2H4	399	.060	.060	100.	60.	235.0	54.0	71.0	79.0	76.0	1.090	1.190	MIX	*	3916.7	.065	.479	.982	1.210	.70-04
N2H4	400	.060	.060	100.	60.	235.0	53.0	71.0	78.0	84.0	1.060	1.240	MIX	*	3916.7	.118	.479	.976	1.250	.70-04
N2H4	401	.060	.060	100.	60.	235.0	51.0	71.0	83.0	87.0	1.020	1.360	MIX	*	3916.7	.146	.479	.955	1.353	.70-04
N2H4	402	.060	.060	100.	60.	235.0	51.0	69.0	83.0	99.0	1.600	1.320	MIX	*	3916.7	.354	.479	.972	1.270	.72-04
N2H4	403	.060	.050	100.	60.	255.0	50.0	61.0	98.0	103.0	1.160	1.050	MIX	*	4250.0	.529	.466	.999	1.045	.82-04
N2H4	404	.060	.060	100.	60.	215.0	49.0	50.0	97.0	108.0	1.160	.882	MIX	*	3583.3	.907	.494	.951	.728	.10-03
N2H4	405	.060	.060	100.	60.	235.0	48.0	69.0	99.0	48.0	.993	1.440	MIX	*	3916.7	.007	.479	.924	1.492	.72-04
N2H4	406	.060	.060	100.	60.	235.0	56.0	66.0	63.0	66.0	1.020	.980	MIX	*	3916.7	.032	.479	.999	.963	.76-04
N2H4	407	.060	.060	100.	60.	235.0	52.0	65.0	63.0	66.0	1.140	1.090	MIX	*	3916.7	.033	.479	.997	1.084	.77-04
N2H4	408	.060	.060	100.	60.	235.0	54.0	65.0	63.0	66.0	1.110	1.080	MIX	*	3916.7	.033	.479	1.000	1.005	.77-04
N2H4	409	.060	.060	100.	60.	235.0	50.0	65.0	63.0	66.0	1.090	1.210	MIX	*	3916.7	.033	.479	.988	1.172	.77-04
N2H4	410	.060	.060	100.	60.	185.0	36.0	54.0	76.0	85.0	.946	1.620	POP	*	3083.3	.166	.519	.906	1.563	.93-04

HYPERGOLIC STREAM IMPINGMENT DATA COMPLIATION

INVESTIGATOR ZUNG

A L R C MODEL CORRELATION PARAMETERS

FUEL TYPE	TEST NO.	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	COMMENTS	*	PD	IS	R (IN)	EM	SPR	DV (SEC)
N2H4	411	.060	.060	100.	60.	175.0	34.0	55.0	89.0	95.0	.877	1.850	POP	*	2916.7	.336	.529	.836	1.829	.91-04
N2H4	412	.060	.060	100.	60.	190.0	36.0	55.0	87.0	97.0	.919	1.690	POP	*	3166.7	.386	.514	.889	1.627	.91-04
N2H4	413	.060	.060	100.	60.	90.0	40.0	55.0	83.0	89.0	1.030	1.340	POP	*	1500.0	.218	.660	.963	1.319	.91-04
N2H4	414	.060	.060	100.	60.	80.0	39.0	54.0	94.0	105.0	1.010	1.390	POP	*	1333.3	.685	.686	.958	1.339	.93-04
N2H4	415	.060	.060	100.	60.	85.0	44.0	54.0	98.0	108.0	1.140	1.090	POP	*	1416.7	.840	.672	.999	1.054	.93-04
N2H4	416	.060	.060	100.	60.	80.0	43.0	54.0	101.0	110.0	1.130	1.110	POP	*	1333.3	.961	.686	.995	1.106	.93-04
N2H4	417	.060	.060	100.	60.	80.0	41.0	55.0	109.0	116.0	1.050	1.130	POP	*	1333.3	1.405	.686	.972	1.267	.91-04
N2H4	418	.060	.060	100.	60.	80.0	39.0	55.0	102.0	116.0	.950	1.430	POP	*	1333.3	1.405	.686	.947	1.392	.91-04
N2H4	419	.060	.060	100.	60.	80.0	37.2	54.3	102.0	116.0	.980	1.490	POP	*	1333.3	1.424	.686	.924	1.491	.92-04
N2H4	423	.060	.060	100.	60.	105.0	51.7	54.3	109.0	112.0	1.350	.780	POP	*	1750.0	1.093	.627	.969	.778	.92-04
N2H4	424	.060	.060	100.	60.	95.0	50.3	54.3	103.0	114.0	1.320	.820	POP	*	1583.3	1.248	.648	.980	.817	.92-04
N2H4	425	.060	.060	100.	60.	95.0	37.2	53.5	75.0	89.0	.990	1.450	POP	*	1583.3	.225	.648	.938	1.433	.93-04
N2H4	426	.060	.060	100.	60.	95.0	36.2	53.5	64.5	81.5	.970	1.150	POP	*	1583.3	.130	.648	.920	1.505	.93-04
N2H4	427	.060	.060	100.	60.	95.0	34.9	54.7	79.0	81.9	.910	1.720	POP	*	1583.3	.131	.648	.866	1.714	.91-04
N2H4	428	.060	.060	100.	60.	95.0	39.7	54.7	104.0	108.0	1.040	1.330	POP	*	1583.3	.829	.648	.959	1.336	.91-04
N2H4	429	.060	.060	100.	60.	95.0	36.3	54.7	106.0	114.0	.950	1.590	POP	*	1583.3	1.239	.648	.897	1.596	.91-04
N2H4	430	.055	.055	100.	60.	185.0	48.7	58.2	68.0	75.0	1.190	1.000	POP	*	3363.6	.067	.476	1.000	.990	.79-04
N2H4	431	.055	.055	100.	60.	175.0	46.7	58.5	81.0	93.0	1.140	1.100	POP	*	3181.8	.251	.485	.996	1.090	.78-04
N2H4	432	.055	.055	100.	60.	215.0	65.4	74.0	92.5	101.0	1.260	.890	MIX	*	3909.1	.348	.453	.994	.895	.62-04
N2H4	433	.055	.055	100.	60.	215.0	64.4	73.5	97.5	106.0	1.230	.910	MIX	*	3909.1	.494	.453	.996	.912	.62-04
N2H4	434	.055	.055	100.	60.	175.0	51.0	64.5	101.0	114.0	1.200	1.060	MIX	*	3181.8	.963	.485	.994	1.119	.71-04
N2H4	435	.055	.055	100.	60.	75.0	50.1	60.4	96.0	106.0	1.180	1.020	POP	*	1363.6	.601	.643	1.000	1.017	.76-04
N2H4	436	.055	.055	100.	60.	95.0	45.2	59.8	72.5	86.5	1.080	1.230	POP	*	1727.3	.154	.594	.982	1.211	.77-04
N2H4	437	.055	.055	100.	60.	95.0	45.2	59.8	68.0	77.5	1.080	1.230	POP	*	1727.3	.079	.594	.982	1.212	.77-04
N2H4	438	.040	.040	100.	60.	45.0	54.1	50.8	99.0	105.0	1.520	.620	MIX	*	1125.0	.486	.554	.892	.619	.66-04
N2H4	439	.040	.040	100.	60.	45.0	49.5	53.4	94.0	112.0	1.320	.810	MIX	*	1125.0	.741	.554	.978	.810	.62-04
N2H4	440	.040	.040	100.	60.	45.0	57.4	59.7	97.5	102.0	1.370	.760	MIX	*	1125.0	.336	.554	.963	.759	.56-04
N2H4	441	.040	.040	100.	60.	45.0	48.8	53.4	91.0	97.0	1.300	.840	MIX	*	1125.0	.265	.554	.984	.838	.62-04
N2H4	442	.040	.040	100.	60.	45.0	56.5	53.4	107.0	116.0	1.580	.580	MIX	*	1125.0	[illegible]	.554	.898	.628	.62-04
N2H4	443	.040	.040	100.	60.	45.0	54.1	53.4	114.0	125.0	1.450	.680	SEP	*	1125.0	1.727	.554	.932	.686	.62-04
N2H4	444	.040	.040	100.	60.	45.0	60.0	53.4	108.0	108.0	1.600	.550	MIX	*	1125.0	.566	.554	.847	.560	.62-04
N2H4	445	.040	.040	100.	60.	45.0	50.0	57.4	114.0	122.0	1.240	.930	SEP	*	1125.0	1.326	.554	.997	.929	.58-04
N2H4	446	.040	.040	100.	60.	45.0	49.3	57.4	116.0	128.0	1.240	.960	SEP	*	1125.0	1.944	.554	.999	.955	.58-04
N2H4	447	.040	.040	100.	60.	45.0	50.6	66.6	106.0	122.0	1.080	1.220	MIX	*	1125.0	1.143	.554	.981	1.215	.50-04
N2H4	448	.040	.040	100.	60.	55.0	54.1	66.6	104.0	114.0	1.160	1.060	MIX	*	1375.0	.678	.518	.998	1.063	.50-04
N2H4	449	.040	.040	100.	60.	55.0	57.2	66.7	106.0	116.0	1.160	1.060	MIX	*	1375.0	.773	.518	.999	.955	.50-04
N2H4	450	.040	.040	100.	60.	55.0	54.2	66.6	104.0	118.0	1.160	1.060	MIX	*	1375.0	.882	.518	.998	1.057	.50-04
N2H4	451	.040	.040	100.	60.	45.0	45.7	68.2	101.0	106.0	1.130	2.570	MIX	*	1125.0	.387	.554	.905	1.565	.49-04
N2H4	452	.040	.040	100.	60.	45.0	44.4	65.1	97.5	108.0	.970	1.510	MIX	*	1125.0	.465	.554	.921	1.504	.51-04
N2H4	453	.040	.040	100.	60.	50.0	44.9	65.1	91.0	105.0	.980	1.470	MIX	*	1250.0	.379	.535	.930	1.465	.51-04

HYPERGOLIC STREAM IMPINGMENT DATA COMPLIATION

INVESTIGATOR ZUNG

A L R C MODEL CORRELATION PARAMETERS

FUEL TYPE	TEST NO.	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	COMMENTS	*	PD	IS	R (IN)	EM	SPR	DV (SEC)
N2H4	454	.040	.040	100.	60.	65.0	49.8	40.9	114.0	132.0	1.000	1.430	MIX	*	1625.0	3.504	.490	.761	.473	.81-04
N2H4	455	.040	.040	100.	60.	50.0	67.7	68.2	122.0	134.0	1.410	.712	SEP	*	1250.0	2.379	.535	.946	.716	.49-04
N2H4	456	.040	.040	100.	60.	55.0	58.5	66.6	129.0	137.0	1.250	.913	SEP	*	1375.0	2.929	.518	.996	.919	.50-04
N2H4	457	.040	.040	100.	60.	55.0	60.5	66.3	135.0	144.0	1.290	.852	SEP	*	1375.0	4.493	.518	.988	.853	.50-04
N2H4	458	.040	.040	100.	60.	55.0	60.0	64.1	131.0	144.0	1.330	.801	SEP	*	1375.0	4.647	.518	.978	.808	.52-04
N2H4	459	.040	.040	100.	60.	55.0	58.5	62.3	137.0	147.0	1.340	.797	SEP	*	1375.0	5.715	.518	.977	.806	.54-04
N2H4	460	.060	.060	100.	60.	470.0	37.9	66.3	61.5	64.0	.814	2.150	SEP	*	7833.3	.027	.380	.728	2.122	.75-04
N2H4	461	.060	.060	100.	60.	535.0	65.1	66.9	62.5	66.0	1.340	.789	SEP	*	8916.7	.032	.364	.953	.732	.75-04
N2H4	462	.060	.060	100.	60.	535.0	48.4	68.8	62.5	66.0	1.000	1.420	SEP	*	8916.7	.031	.364	.945	1.401	.73-04
N2H4	463	.060	.060	100.	60.	535.0	46.6	68.8	67.0	64.0	.960	1.540	SEP	*	8916.7	.026	.364	.917	1.518	.73-04
N2H4	464	.060	.060	100.	60.	585.0	56.5	68.8	66.0	69.5	1.170	1.040	SEP	*	9750.0	.040	.354	1.000	1.029	.73-04
N2H4	465	.060	.060	100.	60.	475.0	61.3	68.8	67.0	64.0	1.260	.890	SEP	*	7916.7	.026	.379	.991	.877	.73-04
N2H4	466	.060	.060	100.	60.	435.0	54.9	65.7	46.5	52.5	1.190	1.000	SEP	*	7250.0	.011	.390	1.000	.986	.76-04
N2H4	467	.060	.060	100.	60.	455.0	55.9	65.7	48.0	52.5	1.210	.970	SEP	*	7583.3	.011	.385	.999	.952	.76-04
N2H4	468	.060	.060	100.	60.	455.0	61.9	65.7	108.0	110.0	1.350	.790	SEP	*	7583.3	.790	.385	.974	.795	.76-04
N2H4	469	.060	.060	100.	60.	455.0	60.4	68.8	114.0	116.0	1.250	.910	SEP	*	7583.3	1.124	.385	.996	.918	.73-04
N2H4	470	.060	.060	100.	60.	445.0	58.2	68.8	111.0	119.0	1.210	.980	SEP	*	7416.7	1.367	.387	1.000	.984	.73-04
N2H4	471	.060	.060	100.	60.	100.0	46.6	52.8	96.0	92.0	1.260	.900	POP	*	1666.7	.282	.637	.995	.904	.95-04
N2H4	472	.060	.060	100.	60.	100.0	42.6	52.6	64.5	72.0	1.150	1.070	POP	*	1666.7	.064	.637	.999	1.055	.95-04
N2H4	473	.060	.060	100.	60.	100.0	46.6	52.6	63.0	70.0	1.260	.900	POP	*	1666.7	.055	.637	.992	.882	.95-04
N2H4	474	.060	.060	100.	60.	100.0	42.8	52.6	59.5	62.0	1.160	1.060	POP	*	1666.7	.029	.637	.999	1.046	.95-04
N2H4	475	.040	.040	100.	60.	630.0	59.5	77.9	68.0	64.0	1.090	1.200	SEP	*	15750.0	.015	.230	.984	1.195	.43-04
N2H4	476	.040	.040	100.	60.	80.0	73.5	81.7	68.0	64.0	1.280	.870	MIX	*	2000.0	.015	.457	.989	.861	.41-04
N2H4	477	.040	.040	100.	60.	85.0	61.3	83.2	61.0	66.0	1.050	1.290	MIX	*	2125.0	.017	.448	.971	1.275	.40-04
N2H4	478	.040	.040	100.	60.	640.0	65.4	70.0	59.5	66.0	1.330	.807	MIX	*	16000.0	.020	.229	.973	.792	.48-04
N2H4	479	.060	.060	100.	60.	100.0	46.5	52.8	58.0	71.5	1.250	.905	POP	*	1666.7	.062	.637	.994	.896	.95-04
N2H4	480	.060	.060	100.	60.	100.0	48.4	53.7	38.0	64.0	1.280	.860	POP	*	1666.7	.034	.637	.991	.873	.93-04
N2H4	481	.060	.060	100.	60.	23.0	26.5	35.1	128.0	132.0	1.060	1.240	POP	*	383.3	6.125	1.039	.976	1.246	.14-03
N2H4	482	.050	.060	100.	60.	147.0	25.4	34.9	135.0	141.0	1.030	1.330	POP	*	2450.0	10.692	.560	.957	1.344	.14-03
N2H4	483	.060	.060	100.	60.	175.0	43.1	65.1	51.5	60.5	.946	1.600	POP	*	2916.7	.021	.529	.904	1.571	.77-04
N2H4	484	.060	.060	100.	60.	185.0	54.1	64.1	51.5	60.5	1.200	.986	POP	*	3083.3	.021	.519	.999	.967	.78-04
N2H4	485	.040	.040	100.	60.	220.0	54.1	62.6	57.5	60.5	1.230	.938	UNDEF	*	5500.0	.015	.327	.997	.927	.53-04
N2H4	486	.040	.040	100.	60.	90.0	54.1	64.1	54.5	58.5	2.510	.471	MIX	*	2250.0	.012	.440	1.000	.970	.52-04
N2H4	487	.040	.040	100.	60.	100.0	54.1	63.1	56.0	58.5	1.220	.952	MIX	*	2500.0	.012	.425	.998	.941	.53-04
N2H4	488	.040	.040	100.	60.	100.0	54.1	63.8	56.0	58.5	1.210	.970	MIX	*	2500.0	.012	.425	.999	.962	.52-04
N2H4	489	.040	.040	100.	60.	100.0	54.1	63.8	56.0	58.5	1.210	.970	MIX	*	2500.0	.012	.425	.999	.962	.52-04
N2H4	490	.040	.040	100.	60.	150.0	39.8	43.4	62.5	62.5	1.310	.830	MIX	*	3750.0	.025	.371	.982	.826	.77-04
N2H4	491	.040	.040	100.	60.	30.0	38.0	43.4	51.5	56.5	1.250	.910	MIX	*	750.0	.015	.634	.994	.900	.77-04
N2H4	492	.040	.040	100.	60.	30.0	38.6	41.4	64.5	60.0	1.370	.750	MIX	*	750.0	.021	.634	.976	.801	.81-04
N2H4	493	.040	.040	100.	60.	30.0	33.2	40.8	56.0	60.0	1.160	1.060	MIX	*	750.0	.021	.634	.999	1.044	.82-04

HYPERGOLIC STREAM IMPINGMENT DATA COMPLIATION

INVESTIGATOR ZUNG

A L R C MODEL CORRELATION PARAMETERS

FUEL TYPE	TEST NO.	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	COMMENTS	*	PD	IS	P (IN)	EM	SPR	DV (SEC)
N2H4	494	.040	.040	100.	60.	30.0	33.9	40.8	56.0	62.0	1.160	1.040	MIX	*	750.0	.025	.634	1.000	1.000	.82-04
N2H4	495	.040	.040	100.	60.	35.0	38.3	43.4	56.0	64.5	1.260	.900	MIX	*	875.0	.029	.602	.993	.886	.77-04
N2H4	496	.040	.040	100.	60.	35.0	36.6	43.4	56.0	66.0	1.210	.980	MIX	*	875.0	.033	.602	1.000	.969	.77-04
N2H4	497	.040	.040	100.	60.	30.0	39.8	44.8	56.0	66.0	1.270	.890	MIX	*	750.0	.032	.634	.991	.873	.74-04
N2H4	498	.040	.040	100.	60.	30.0	39.8	44.8	58.0	66.0	1.270	.890	MIX	*	750.0	.032	.634	.991	.875	.74-04
N2H4	499	.040	.040	100.	60.	30.0	39.6	43.4	56.0	64.5	1.310	.830	MIX	*	750.0	.029	.634	.982	.829	.77-04
N2H4	500	.040	.040	100.	60.	30.0	39.6	43.4	56.0	66.0	1.310	.830	MIX	*	750.0	.033	.634	.982	.828	.77-04
N2H4	501	.040	.040	100.	60.	30.0	30.6	38.3	62.5	74.0	1.140	1.090	MIX	*	750.0	.069	.634	.997	1.082	.87-04
N2H4	502	.040	.040	100.	60.	30.0	33.2	37.3	64.5	69.0	1.270	.880	MIX	*	750.0	.048	.634	.991	.875	.89-04
N2H4	503	.040	.040	100.	60.	30.0	33.2	38.3	66.0	74.0	1.230	.930	MIX	*	750.0	.069	.634	.997	.922	.87-04
N2H4	504	.040	.040	100.	60.	30.0	33.7	31.2	64.5	74.0	1.540	.598	MIX	*	750.0	.084	.634	.874	.593	.11-03
N2H4	505	.040	.040	100.	60.	14.7	20.7	17.2	72.0	92.0	1.710	.488	SEP	*	367.5	.578	.804	.764	.476	.19-03
N2H4	506	.040	.040	100.	60.	14.7	21.4	21.7	72.0	72.0	1.400	.721	SEP	*	367.5	.104	.804	.946	.716	.15-03
N2H4	507	.027	.027	100.	60.	14.7	41.4	27.4	71.0	71.0	2.200	.296	SEP	*	544.4	.051	.543	.513	.305	.82-04
N2H4	508	.027	.027	100.	60.	14.7	40.3	39.2	68.0	70.0	1.480	.650	MIX	*	544.4	.033	.543	.917	.658	.57-04
N2H4	509	.027	.027	100.	60.	14.7	47.1	53.2	68.0	68.0	1.270	.890	MIX	*	544.4	.021	.543	.993	.888	.42-04

LIST OF APPENDIX D

DATA SOURCES

1. Investigator - Nurich, W. H. and Cosdill, J. P., "Reactive Stream Separation Photography", Final Report R8490, Contract NAS 7-720, Rocketdyne, 1971

2. Investigator - Houseman
   Lee, A., and Houseman, J., "Popping Phenomena with N_2O_4/N_2H_4 Injectors" presented at the Western States Section Meeting of the Combustion Institute on Stable Combustion of Liquid Propellant, JPL, Oct. 26-27, 1970

3. Investigator-Zung
   Zung, L. B., and White, S. R., "Combustion Process of Impinging Hypergolic Propellants", NASA CR 1704, Marshall Industries, Irvine, California, May 1971

PROPELLANT STREAM HEATING
MODEL

```
QIR FOR,* MAIN,MAIN                                                                11 DEC 73   00:00:04.784
DATE, TIME, LEVEL OF OUTPUT ELEMENT: 11 DEC 73  11:14(03)
FORTRAN V:  ISD VERSION 2.9

  MAIN PROGRAM

  STORAGE USED (BLOCK, NAME, LENGTH)

      0001    *CODE    000423
      0000    *DATA    002565
      0002    *BLANK   000000
      0003    DATAI    000015
      0004    BLK2     000040


  EXTERNAL REFERENCES (BLOCK, NAME)

      0005    DATA
      0006    NRDU$
      0007    NIO1$
      0010    NIO2$
      0011    NRNL$
      0012    SIN
      0013    ALOG
      0014    EXP
      0015    NEXP6$
      0016    NWDU$
      0017    NSTOP$


  STORAGE ASSIGNMENT FOR VARIABLES (BLOCK, TYPE, RELATIVE LOCATION, NAME)

   0000     002365 1000F     0000     002366 1001F     0001     000006 117G      0001     000027 133G      0001     000053 142G
   0001     000414 2L        0000     002501 2001F     0001     000323 206G      0000     002525 3000F     0000     002530 5000F
   0003 R 000001 DF         0003 R 000000 DO         0000 R 002345 DV         0000 R 002334 DVF        0000 R  02341 EM
   0000 I 002330 I          0003 I 000011 ICOM       0000 I 002306 ICOMN      0003 I 000012 IFUEL      0000 I     304 IFUELN
   0000 I 002324 II         0003 R 000013 IMP        0000 I 002327 INDEX      0000 I 000334 INV        0000 I 002331 INVEST
   0000 I 002312 INVN       0000 I 002321 IPAGE      0000 I 002346 IPRNT      0000 I 002326 IPROC      0000 R 002315 IS
   0000 I 000024 ITEST      0000 I 002316 I$         0000 I 002323 J          0000 I 002322 K          0003 R 000010 MOM
   0003 R 000007 MR         0000 I 002344 NN         0000 I 002317 NSETS      0000 I 002325 NTEST      0003 R 000002 PC
   0000 R 002342 PD         0000 R 002336 R          0003 R 000014 RHF        0000 R 002333 RHOO       0000 R 002340 RN
   0000 R 002337 RMN        0004 R 000030 SGA50      0004 R 000010 SGN2H      0000 R 002332 SGN204     0000 R 002343 SPR
   0000 R 002335 T          0004 R 000020 TA50       0003 R 000006 TF         0000 R 000000 TITLE      0004 R 000000 TN2H4
   0003 R 000005 TO         0003 R 000004 VF         0003 R 000003 VO         0000 R 002320 XLD


 00101      1*           DIMENSION TITLE(20),ITEST(200),INV(1000),
 00101      2*          1          IFUELN(2),ICOMN(4),INVN(3)
 00101      3*      C
 00103      4*           REAL IMP,MOM,MR,IS
 00104      5*           COMMON/DATAI/DO,DF,PC,VO,VF,TO,TF,MR,MOM,ICOM,IFUEL,IMP,RHF
 00105      6*           COMMON/BLK2/ TN2H4(8),SGN2H(8),TA50(8),SGA50(8)
 00106      7*           DATA INVN/' LONG','NURICK','HOUSEM'/
 00110      8*           DATA ICOMN/'  MIX ','  SEP ','  POP ',' UNDEF'/
 00112      9*           DATA IFUELN/'N2H4','A-50 '/
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
C
      NAMELIST/INPUT/TITLE,ITEST,NSETS,INV,
C
      READ(5,1000) TITLE
C
      READ(5,INPUT)
C                  HERE WE SET THE CASES TO BE PROCESSED
C                        NSETS  =  NO. OF GROUPS OF SEQUENCEIAL TESTS
C                        ITEST  =  RANGE OF TESTS IN SEQUENCE ITEST(I)-ITEST(N)
C                        INV    =  INVESTIGATORS  FLAG  1 ZUNG, 2 NURICK
C
C
      XLD=100.
      IPAGE=0
      K=0
      J=1
      DO 1 II=1,NSETS
      NTEST=ITEST(J+1)-ITEST(J)+1
      IPROC=NTEST+ITEST(J)-1
      INDEX=ITEST(J)
      J=J+2
C
C                  HERE WE START PROCESSING EACH TEST OF NSETS
C
      DO 2 I=INDEX,IPROC
C                          CHECK FOR INVESTIGATORS
      IPAGE=IPAGE+1
      K=K+1
      INVEST=INV(K)
      CALL DATA(INVEST,I)
      IF(VO .LE. 0. ) IPAGE=IPAGE-1
      IF(VO .LE. 0. ) GO TO 2
C
C                  CALCULATE ALRC MODEL CORRELATION PARAMETERS
C
      SGN204=(12.5E-4*(11.6-TO)+1.515)+(11.2E-6*100.)
      RHOO=SGN204*62.40
      DVF = DF/12./VF/SIN(0.5*IMP/57.3)
      T= TF+460.
      IS  = EXP(ALOG(DVF)+ ...J -(21800./T)))
      K   = 49.2 * DF/ PC**0.333
      RNN =(RHOO* VO * VO * DO)/( RHF * VF* VF * DF)
      RN  = 1.0 / (1.0 + RNN )
      EM  = (1.0- (1.0-2.0*RN)**2)**2
      PD=PC/DF                                                          *NEW
C
C                  CALCULATE RUPE STAGNATION PRESSURE RATIO
C
      SPR =(RHF * VF * VF)/(RHOO * VO * VO)
C
C                  CALCULATE JPL MODEL PARAMETERS
C
      IF(INVEST .EQ. 3) NN='AN'
      IF(INVEST .NE. 3) NN='
      DV = DF/12.0/VF
      IF(IPAGE .GT. 40) IPAGE=1
      IF( K .GT. 1 .AND.(INV(K)-IPRNT) .NE. 0) IPAGE=1
      IF( K .GT. 1 .AND. IPAGE .EQ. 1) WRITE(6,5000)
      IF(IPAGE .EQ. 1) WRITE(6,3000) TITLE
      IF(IPAGE .EQ. 1) WRITE(6,1001) INVN(INVEST),NN
```

```
00217    70*        WRITE(6,2001) IFUELN(IFUEL),I,DO,DF,XLD,IMP,PC,VO,VF,TO,TF,MR,
00217    71*       1MOM,ICOMN(ICOM),PD,IS,R,  ,SPR,DV                                   *NEW
00245    72*        IPRNT=INVEST                                                        **-1
00246    73*      2 CONTINUE
00250    74*      1 CONTINUE
00252    75*   1000 FORMAT(20A4)
00253    76*   1001 FORMAT(//T50,'HYPERGOLIC  STREAM  IMPINGMENT  DATA  COMPLIATION',
00253    77*       1///T26,'INVESTIGATOR   ',A6,A2,T91,'A L R C MODEL CORRELATION PARA
00253    78*       AMETERS',
00253    79*       2    ///T32,'IMP',/T4,'FUEL TEST  DO    DF   L/D  ANGLE  PC     VO',
00253    80*       3T49,'VF     TO     TF      MR  MF/MO   COMMENTS * ',  T93,'PD',        *NEW
00253    81*       4T101,'IS',T108,'R',T114,'EM',T120,'SPR',T128,'DV',/                 *NEW
00253    82*       5T4,'TYPE  NO. (IN)  (IN)       (DEG)(PSIA)(FT/S)(FT/S) (F)   (F)',    **-2
00253    83*       6T68,          T107,'(IN)',T127'(SEC)',/)                           *NEW
00254    84*   2001 FORMAT(T4,A6,I3,2(F5.3,1X),2(F4.0,1X),5(F5.1,1X),2(F5.3,1X),T81,    **-1
00254    85*       1A6,T89,'*',T90, F7.1,T97,F6.3,1X,F6.3,1X,F5.3,1X,F6.3,E10.2)        *NEW
00255    86*   3000 FORMAT(//40X,20A4,/)                                                **-1
00256    87*   5000 FORMAT(1H1)
00257    88*        END

      END OF UNIVAC 1108 FORTRAN V COMPILATION.     0 *DIAGNOSTIC* MESSAGE(S)
  MAIN           SYMBOLIC                          10 DEC 73  14:18(02)  0  00175000   14   87  (DELETED)
  MAIN     CODE  RELOCATABLE                       10 DEC 73  14:18(02)  0  00177302   14   43  (DELETED)
                                                                         1  00200434   36    1
```

```
@FOR,IS VAPOR
FORTRAN V:  ISD VERSION 4.4S-09/03/74-09:05:38 (,0)

  MAIN PROGRAM

  STORAGE USED: CODE(1) 000326; DATA(0) 000300; BLANK COMMON(2) 000000

   COMMON BLOCKS:

   0003   LIQ    000002
   0004   VAP    000005
   0005   GAS    000004
   0006   MIX    000010

  EXTERNAL REFERENCES (BLOCK, NAME)

   0007   PROPMX
   0010   NINTR$
   0011   NRNL$
   0012   NWNL$
   0013   SIN
   0014   SQRT
   0015   CBRT
   0016   ALOG
   0017   EXP
   0020   NSTOP$

  STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

   0001   000045 10L      0001   000236 15L     0001   000320 20L     0001   000324 30L     0001   000002 5L
   0000 R 000014 ALPHA    0005   000000 CPG     0003 R 000000 CPL     0006 R 000002 CPMX    0004 R 000000 CPV
   0006 R 000004 DMX      0000 R 000004 DO      0000 R 000032 DT      0000 R 000026 DTL     0000 R 000034 DTV
   0000 R 000031 DX       0004 R 000004 HV      0000   000042 INPUT   0000 I 000037 NS      0000 I 000007 NSTEP
   0000   000074 OUT1     0000   000134 OUT2    0000   000155 OUT3    0000   000207 OUT4    0000 R 000002 PC
   0000 R 000033 PCTV     0000 R 000016 PR      0006 R 000006 PV      0000 R 000025 QHV     0000 R 000024 QSH
   0000 R 000022 QTOT     0000 R 000023 QV      0000 R 000012 RED     0003 R 000001 RHOL    0006 R 000005 RHOMX
   0000 R 000010 RM       0000 R 000011 SC      0000 R 000006 SPACE   0006 R 000007 TAVE    0000 R 000001 TB
   0000 R 000005 THETA    0000 R 000000 TL      0000 R 000035 TV      0000 R 000003 U       0000 R 000015 WFV
   0000 R 000027 WL       0000 R 000040 WLV     0000 R 000041 WL1     0000 R 000030 XIMP    0005   000001 XKG
   0006 R 000001 XKMX     0004   000001 XKV     0005   000002 XMUG    0006 R 000003 XMUMX   0004   000002 XMUV
   0005   000003 XMWG     0006 R 000000 XMWMX   0004 R 000003 XMWV    0000 R 000017 XNUH    0000 R 000013 XNUM
   0000 R 000036 XSTEP    0000 R 000021 Z       0000 R 000020 ZZ


 00100      1*     C
 00100      2*     C       PROGRAM TO CALCULATE THE HEAT UP OF A CYLINDRICAL JET
 00100      3*     C       PRIOR TO IMPINGEMENT
 00100      4*     C
 00101      5*             NAMELIST/INPUT/TL,TB,PC,U,DO,THETA,SPACE,NSTEP
 00103      6*             NAMELIST/OUT1/XMWMX,XKMX,CPMX,XMUMX,DMX,PV,TAVE,RHOMX,U,RM        000001
 00104      7*             NAMELIST/OUT2/SC,RED,XNUM,ALPHA,WFV                               000001
 00105      8*             NAMELIST/OUT3/PR,XNUH,ZZ,Z,QTOT,QV,QSH,QHV                        000001
 00105      9*             NAMELIST/OUT4/DTL,RHOL,CPL,WL,TL,XIMP,DX,DT,PCTV,DTV,TV           000001
```

```
00107            COMMON/LIQ/CPL,RHOL                                      000002
00110            COMMON/VAP/CPV,XKV,XMUV,XMWV,HV                          000002
00111            COMMON/GAS/CPG,XKG,XMUG,XMWG                             000002
00112            COMMON/MIX/XMWMX,XKMX,CPMX,XMUMX,DMX,RHOMX,PV,TAVE       000002
00113          5 CONTINUE                                                 000002
00114            READ (5,INPUT,END=30)                                    000002
00117            WRITE(6,INPUT)                                           000006
00122            RM=3./4.*DO                                              000012
00123            U=U*12.                                                  000015
00124            XSTEP=NSTEP                                              000020
00125            THETA=THETA/57.3                                         000023
00126            XIMP=SPACE/2./SIN(THETA)                                 000026
00127            DX=XIMP/XSTEP                                            000035
00130            DT=DX/U                                                  000037
00131            PCTV=0.                                                  000041
00132            NS=0                                                     000042
00133            WLV=0.0                                                  000043
00134         10 CONTINUE                                                 000045
00135            NS=NS+1                                                  000045
00136            CALL PROFMX(TL,TB,PC)                                    000047
00136      C                                                              000047
00136      C     CALCULATE MASS TRANSFER RATE                             000047
00136      C                                                              000047
00137            SC=XMUMX/DMX/RHOMX                                       000054
00140            RED=2.*RM*U*RHOMX/XMUMX                                  000060
00141            XNUM=2.+0.6*SQRT(RED)*CBRT(SC)                           000066
00142            ALPHA=PC/PV*ALOG(PC/(PC-PV))                             000102
00143            WFV=2.*3.14159*DMX*XMWV*RM*ALPHA*XNUM*PV/18510./TAVE*1.25 000116
00143      C                                                              000116
00143      C     CALCULATE HEAT TRANSFER RATE                             000116
00143      C                                                              000116
00144            PR=CPMX*XMUMX/XKMX                                       000131
00145            XNUH=2.0+0.6*CBRT(PR)*SQRT(RED)                          000135
00146            ZZ=WFV*CPV/2./3.14159/XKMX/RM/XNUH                       000144
00147            IF(ZZ.GE.80) ZZ=80.                                      000154
00151            Z=ZZ/(EXP(ZZ)-1.)                                        000163
00152            QTOT=2.*3.14159*XKMX*XNUH*RM*(TB-TL)*1.25                000172
00153            QV=QTOT*Z                                                000203
00154            QSH=QTOT-QV                                              000205
00155            QHV=WFV*HV                                               000207
00156            DTV=QSH/CPV/WFV                                          000212
00157            TV=TL+DTV                                                000215
00160            IF(TV.LT.2500) GO TO 15                                  000217
00162            DTV=2500.-TL                                             000225
00163            TV=2500.                                                 000226
00164            QSH=(2500.-TL)*CPV*WFV                                   000230
00165            QV=QTOT-QSH                                              000233
00166         15 CONTINUE                                                 000236
00167            WL1=3.14159/4.*(DO**2.)*XIMP*RHOL                        000236
00170            WL=4./3.*3.14159*(RM**3.)*RHOL                           000243
00171            WLV=WLV+WFV*DT                                           000251
00172            PCTV=WLV/WL1*100.                                        000255
00173            DTL=(QV-WFV*HV)/CPL/WL*DT                                000260
00174            TL=TL+DTL                                                000267
00175            WRITE(6,OUT1)                                            000271
00200            WRITE(6,OUT2)                                            000275
00203            WRITE(6,OUT3)                                            000301
```

```
09/03/74  9:05:35 1RSS   000427139    000427          S30   15                                   DATE 090374        PA      4

00205     67*              WRITE(6 OUT4)                                                             000305
00211     68*              IF(NS.GE.NSTEP) GO TO 20                                                  000311
00213     69*              GO TO 10                                                                  000316
00214     70*           20 CONTINUE                                                                  000320
00215     71*              THETA=THETA*57.3                                                          000320
00216     72*              GO TO 5                                                                   000322
00217     73*           30 CONTINUE                                                                  000325
00220     74*              END                                                                       000325

      END OF COMPILATION:        NO  DIAGNOSTICS.
```

```
@FOR,IS PROPMX
FORTRAN V:  ISO VERSION 4.4S-09/03/74-09:05:42 (,0)

   SUBROUTINE PROPMX    ENTRY POINT 000167

   STORAGE USED: CODE(1) 000202; DATA(0) 000064; BLANK COMMON(2) 000000

    COMMON BLOCKS:

    0003  LIQ     000002
    0004  VAP     000005
    0005  GAS     000004
    0006  MIX     000010

   EXTERNAL REFERENCES (BLOCK, NAME)

    0007  EXP
    0010  XPRR
    0011  NERR3$

   STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

    0005 R 000000 CPG     0003 R 000000 CPL     0006 R 000002 CPMX    0004 R 000000 CPV     0000 R 000000 C1
    0000 R 000001 C2      0006 R 000004 DMX     0004 R 000004 HV      0000   000042 INJP$   0006 R 000006 PV
    0003 R 000001 RHOL    0006 R 000005 RHOMX   0006 R 000007 TAVE    0005 R 000001 XKG     0006 R 000001 XKMX
    0004 R 000001 XKV     0005 R 000002 XMUG    0006 R 000003 XMUMX   0004 R 000002 XMUV    0005 R 000003 XMWG
    0006 R 000000 XMWMX   0004 R 000003 XMWV


00101               SUBROUTINE PROPMX (TL,TB,PC)
00101         C
00101         C     SUBROUTINE TO CALCUATE N2H4 LIQUID AND VAPOR PROPERTIES
00101         C     AND N2H4/NTO GAS PROPERTIES
00101         C
00103               COMMON/LIQ/CPL,RHOL
00104               COMMON/VAP/CPV,XKV,XMUV,XMWV,HV
00105               COMMON/GAS/CPG,XKG,XMUG,XMWG
00106               COMMON/MIX/XMWMX,XKMX,CPMX,XMUMX,DMX,RHOMX,PV,TAVE
00107               TAVE=(TL+TB)/2.
00107         C
00107         C     CALC LIQUID PROPERTIES
00107         C
00110               CPL=.583125+2.80708E-4*TL                                     000003
00111               RHOL=3.062518E-2+4.028897E-5*TL-5.54321E-8*(TL**2.)           000007
00111         C                                                                   000007
00111         C     CALC VAPOR PROPERTIES                                         000007
00111         C                                                                   000007
00112               CPV=.336+1.804E-4*TAVE                                        000020
00113               XKV=1.23753E-6+2.230358E-10*TAVE                              000023
00114               XMUV=4.19981E-8+9.581164E-10*TAVE                             000027
00115               XMWV=32.084                                                   000033
```

```
00116   23*          PV=EXP(14.328787-(7363.22/(TL-63.1713)))                     000035
00117   24*          HV=730.747-0.3591305*TL+1.214E-4*(TL**2.)                    000047
00117   25*     C                                                                 000047
00117   26*     C    CALC GAS PROPERTIES                                          000047
00120   27*          CPG=0.517                                                    000056
00121   28*          XKG=4.0E-6                                                   000060
00122   29*          XMUG=4.74E-6                                                 000062
00123   30*          XMWG=20.82                                                   000064
00123   31*     C                                                                 000064
00123   32*     C    CALC VAPOR MIX MEAN PROPERTIES                               000064
00123   33*     C                                                                 000064
00124   34*          C1=(1.-PV/2./PC)                                             000066
00125   35*          C2=PV/2./PC                                                  000073
00126   36*          XMWMX=C1*XMWG+C2*XMWV                                        000075
00127   37*          CPMX=C1*XMWG/XMWMX*CPG+C2*XMWV/XMWMX*CPV                     000102
00130   38*          XKMX=C1*XKG+C2*XKV                                           000111
00131   39*          XMUMX=C1*XMUG+C2*XMUV                                        000115
00132   40*          DMX=(.63+.001*(TAVE-2000.))*(300./F  /(XMWMX**(.83-.06*(((TAVE-300   000122
00132   41*         *0.)/1000.)**2.)))                                            000122
00133   42*          RHOMX=PC*XMWMX/TAVE/18510.                                   000146
00134   43*          RETURN                                                       000152
00135   44*          END                                                          000201
```

END OF COMPILATION: NO DIAGNOSTICS.

@FIN

RSS DATA STORAGE AND DATA
REDUCTION PROGRAM

```
      SUBROUTINE DATA(INVEST,I)
      DIMENSION IFUEL3(59),XMR3(59),ICOM3(59),IMP3(59),XPC3(59),XVO3(59)
     1,XTO3(59),XMOM3(59),XDO3(59)
     2,ICOM4(197),XPC4(197),XTO4(197),XTF4(197),XMR4(197),IMP4(197),XMO4
     3(197),XVF4(197),XDO4(197),XDF4(197),IFUEL4(197),SPACE4(197),
     4TIMP4(197),ICOM5(145),XPC5(145),XTO5(145),XTF5(145),XMR5(145),
     5IMP5(145),XDO5(145),XDF5(145),XVF5(145),SPACE5(145),IFUEL5(145)
     6,ICOM6(181),XPC6(181),XMO6(181),XMF6(181),XTO6(181),XTF6(181)          6
     7,IFUEL6(181),SPACE6(181),IMP6(181),XDO6(181),XDF6(181),XMR6(181)       6
     8,XAT4(197)                                                            *NEW
      REAL IMP5
      REAL MR,MOM,IMP,IMP1,IMP2,IMP3,IMP4
      COMMON/DATA1/DO,DF,PC,VO,VF,TC,TF,MR,MOM,ICOM,IFUEL,IMP,RMF,SPLD
     1,MF,TIMP,MO,XAT                                                       *NEW
      COMMON/BLK1/ XDO1(509),XDF1(509),XPC1(509),XVO1(509),XVF1(509),       **=1
     1             XTO1(509),XTF1(509),XMR1(509),XMOM1(509),ICOM1(509),
     2             IFUEL1(509),IMP1(509),SPACE1(509),XMF1(509),
     3             XDO2(56),XDF2(56),XPC2(56),XVO2(56),XVF2(56),
     4             XTO2(56),XTF2(56),XMR2(56),XMOM2(56),ICOM2(56),
     5             IFUEL2(56),IMP2(56)
      COMMON/BLK2/TN2H4(8),SGN2H4(8),TA50(8),SGA50(8),TN2O4(10),
     1SN2O4(10) ,TMMH(8),SGMMH(8) ,SGFUEL,SGN2O4
C
C     ************ PHYSICAL PROPERTIES OF FUEL ************************
C
C             A-50
C
      DATA TA50  /0.,100.,200.,300.,400.,500.,550.,600./
      DATA SGA50 / 0.93,0.890,.835,0.780,0.710,0.620,0.565,0.480/
C
C             HYDRAZINE
C
      DATA TN2H4/
     1          0., 100.,200.,300.,400.,500.,600.,700./
      DATA/SGN2H4 /
     1            1.04,0.99,0.94,0.82,0.89,0.75,0.67,0.53/
C
C             MMH
C
      DATA TMMH /0.,50.,100.,150.,200.,300.,400.,500./
      DATA SGMMH /.9103,.88446,.8583,.8325,.8067,.7404,.6651,.5817/
C
C
C     ************ PHYSICAL PROPERTIES OF OXIDIZER ********************
C
C             N2O4
C
      DATA TN2O4/
     1            11.8,32.,50.,68.,77.,95.,104.,113.,118.,129.2/
      DATA SN2O4 /
     1            1.515,1.49,1.47,1.447,1.431,1.412,1.4,1.388,1.379,1.363/
C
C
C     *********   INVESTIGATOR  ***  ZUMG  ***  ( INV = 1 )   ********
C
      DATA ICOM1/
     128*2,29*0,1,2*0,2,0,  2*1,3*0,2,10*0,2,1,3*2,0,2,3*0,2*1,2*2,4*1,
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20,1,3*2,4,5*0,3*2,2*1,2*2,0,3*4,2,3*4,5*2,18*3,3*2,3*0,2,1,2*3,1,
311*0,4*1,0,4,2*1,2*0,2*1,3*0,3*1,4,6*1,2*0,32*1,4,7*0,8*2,1,4,3*1,
A2,0,
42,4*1,2,4,2*2,3*1,3*2,6*1,3*2,1,0,4*1,4,0,2*1,0,2*1,2*2,7*1,0,2,
51,3*3,5*1,0,3,1,3,1,2*2,5*1,0,1,3,2*2,2*3,1,3,2*2,5*3,21*3,4,2*3,
64,4*3,33*3,2,16*1,9*3,13*3,3*1,3*3,5*1,2,1,2*2,8*1,13*2,3*2,4*3,2,
73*3,6*3,4,6*1,13*1,3*2,2*1/
 DATA XPC1 /
1163*14.7,149.,189.,187.,189.,0.,209.,111.,191.,2*0.,172.,187.,
2 3*0.,163.,165.,140.,259.,157.,119.,131.,155.,194.,194.,2*0.,170.,
3 152.,174.,169.,0.,194.,187.,164.,181.,203.,178.,2*0.,110.,115.,
4 115.,17*110.,7*0.,350.,380.,0.,353.,353.,346.,362.,361.,145.,
5 238.,230.,176.,176.,338.,0.,400.,215.,115.,0.,218.,384.,307.,
6 507.,520.,84.,100.,122.,423.      ,461.,461.,115.,130.,149.,
7 169.,.38.,203.,388.,381.,353 .,176.,0.,179.,176.,176.,138.,
8 279.,0.,237.,250.,0.,100.,1.5.,326.,282.,228.,192.,182.,186.,174.
9,186.,162.,0.,362.,180.,14.7,14.7,68.,76.,106.,122.,100.,192.,0.,
1    28*14.7,75.,80.,95.,96.,70.,80.,85.,125.,75.,75.,145.,145.,
2 145.,5*165.,185.,185.,3*165.,175.,6*165.,6*105.,5*185.,3*95.,
3165.,14*175.,2*195.,415.,235.,225.,235.,225.,5*235.,255.,215.,
4 5*235.,185.,175.,190.,90.,80.,85.,80.,80.,80.,80.,3*0.,105.,
5 6*95.,185.,175.,2*215.,175.,75.,2*95.,
* 10*45.,3*55.,2*45.,50.,65.,50.,4*55.,470.,535.,2*535.,585.,475.
5,435.,3*455.,445.,4*100.,630.,80.,85.,640.,2*100.,23.,147.,175.,
7 185.,220.,90.,3*100.,150.,30.,3*30.,2*35.,8*30.,5*14.7/
 DATA XDU1 /
1            117*0.027,23*0.060,151*0.040,0.,5*0.060,28*0.040,47*.06,
2            21*0.055,36*0.060,8*0.055,22*0.040,15*0.060,4*0.040,
3            6*.060,22*.040,3*.027/
 DATA XDF1 /
1            117*0.027,23*0.060,151*0.040,0.,5*0.060,28*0.040,47*0.6,
2            21*0.055,36*0.060,8*0.055,22*0.040,15*0.060,4*0.040,
3            6*.060,22*.040,3*.027/
 DATA IMP1/509*60./
 DATA IFUEL1/509*1/
 DATA SPACE1/509*4.0/
 DATA(XWF1(J),J=1,280)/
*14*.000,.0087,12*.0000,.0156,29*.000,.0110,2*.000,.0100,.0076,
*.0128,.0132,3*0.000,.0195,10*.000,.0062,.0134,.0132,.0133,0.00,0.,
*.0118,3*.000,.0060,.0233,.0233,.0233,.0147,.0139,.0164,2*.0072,
*.0072,.0158,.0082,.0089,.0059,5*.00,.0088,.0075,.0077,.0059,.0082,
*.0082,.0067,.0000,.0067,.0061,.0172,.0042,.0046,.0118,.0227,.0216,
*.0158,.0135,.0108,.0071,.0208,.0172,.0130,.0113,.0100,.0150,.0168,
*.0108,.0183,.0153,.0000,.0153,.0253,.0139,.0113,.0094,.0076,3*.0,
*.0094,.0151,.0154,.0104,.0104,11*0.000,.0119,.0126,.0126,.0135,0.,
*.0144,.0082,.0144, 2*0.00,.0145,.0145,3*.000,.0126,.0129,.0111,
*.0106,.0158,.0074,.009      29,.0147,.0160,2*0.000,.0136,.0147,
*.0167,.0164,.0000,.0        .72,.0147,.0176,.0172,.0172,2*0.000,
*.0194,.0189,.0163,.         217,.0189,.0201,.0189,.0189,2*0.000,
*.0368,.0000,.0368,.[illegible].0345,.0368,.0368,.0368,.0368,7*0.000,
*.0361,.0361,.0000,.0368,.0368,.0340,.0368,.0368,.0146,.0368,.0368,
*.0375,.0375,.0352,.0000,.0334,.0360,.0354,.0000,.0368,.0354,.0272,
*.0208,.0208,.0285,.0354,.0361,.0200,.0203,.0200,.0200,.0225,.0285,
*.0288,.0334,.0375,.0368,.0312,.0285,.0389,.0000,.0341,.0341,.0250,
*.0278,.0400,.0000,.0397,.0397,.0000/
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      DATA(XWF1(J),J=281,460)/
     *      .0690,.0690,.0530,.0500,.0420,.0340,.0270,.0180,.0280,.0300,
     *,0290,00,,.0650,.0290,.034,.033,.30,.29,.029,.030,2*.031,0.000,
     *.0230,.0100,.0100,.0260,.0298,.0350,5*.0370,0.000,
     *.0340,.0290,.0150,.0150,.0100,.0100,.0110,.0100,.0090,.0300,.0300,
     *.0300,.0300,.0300,.0300,.0390,.0550,.0630,.0730,.0390,.0550,.0730,
     *.0630,.0740,.0630,.0630,.0630,.0630,.0630,.0620,.0630,.0630,.0630,
     *.0640,.0640,.0630,.0620,.0620,.0640,.0640,.0640,.0620,.0640,.0640,
     *.0760,.0640,.0650,.0640,.0650,.0640,.0650,.0650,.0620,.0630,.0620,
     *.0630,.0620,.0620,.0620,.0620,.0620,.0620,.0620,.0620,.0630,.0630,
     *.0630,3*.0620,2*0.,.0580,.0880,.0580,.0750,.0760,.0750,.0900,
     *.0900,.0900,.0900,.0900,.0900,.0900,.0900,.0870,.0770,.0760,.0870,
     *.0830,.0830,.0880,.0830,.0690,.0690,.0690,.0700,.0690,.0690,.0680,
     *.0690,.0690,.0680,.0680,.0680,.0690,.0690,.0690,.0680,.0680,.0690,
     *.0690,.0690,.0600,.0600,.0760,.0760,.0620,.0620,.0620,.0620,.0280,
     *.0200,.0330,.0300,.0290,.0290,.0290,.0310,.0310,.0360,.0360,.0360,
     *.0360,.0370,.0350,.0350,.0390,.0370,.0360,.0360,.0350,.0360,.0840/
      DATA(XWF1(J),J=461,509)/
     *.0850,.0870,.0870,.0870,.0870,.0830,.0830,.0830,.0870,.0870,.0670,
     *,0670,.0670,.0670,.0420,.0450,.0450,.0380,.0670,.0680,.0450,.0440,
     *.0350,.0350,.0340,.0170,.0340,.0350,.0350,.0240,.0240,.0230,.0220,
     *.0220,.0240,.0240,.0240,.0240,.0240,.0240,.0210,.0200,.0210,.0170,
     *.0090,.0120..0070,.0100,.0130/
      DATA (XVU1(J),J=1,393)/
     *           14*0.,23.,12*0.,44.,29*0.,55.,2*0.,42.,0.0,41.,45.,3*0.,
     *71.,10*0.,20.,41.,34.,40.,41.,0.0,38.,3*0.,19.,53.,53.,65.,43.,
     *39.,61.,22.,0.0,23.,40.,20.,20.,18.,5*0.,47.,42.,25.,23.,27.,24.,
     *18.,0.0,18.,16.,52.,14.,17.,36.,68.,13.,8.3,6.6,5.4,4.3,13.,9.1,
     *8.3,8.0,10.,9.9,9.3,4.3,12.,8.2,0.0,9.6,14.,22.,18.,13.,12.,3*0.,
     *21.,24.,24.,16.,14.,11*0.,16.,23.,24.,23.,0.0,24.,15.,23.,2*0.,
     *22.,22.,3*0.,21.,19.,18.,20.,19.,17.,17.,22.,27.,26.,2*0.,25.,24.,
     *25.,24.,0.0,24.,16.,24.,23.,23.,20.,2*0.,31.,33.,33.,29.,28.,29.,
     *29.,30.,30.,2*0.,56.,0.0,56.,0.0,56.,54.,59.,55.,59.,7*0.,51.,55.,
     *0.0,68.,50.,48.,56.,30.,22.,65.,74.,55.,55.,39.,0.0,57.,58.,61.,
     *0.0,61.,56.,45.,35.,36.,49.,56.,56.,32.,32.,32.,31.,34.,40.,46.,
     *51.,56.,58.,58.,55.,49.,0.0,56.,58.,55.,42.,75.,0.0,61.,66.,0.0,
     *101.,117.,84.,76.,63.,51.,44.,46.,49.,54.,44.,0.0,92.,46.,64.,49.,
     *49.,46.,36.,46.,47.,36.,0.0,29.,13.,16.,52.,49.,58.,58.,58.,64.,
     *64.,63.,0.0,63.,54.,23.,27.,18.,18.,18.,19.,18.,23.,22.,21.,22.,
     *21.,21.,27.,34.,40.,34.,26.,34.,36.,43.,45.,36.,41.,42.,41.,43.,
     *43.,45.,44.,32.,33.,40.,47.,41.,42.,42.,44.,36.,41.,42.,42.,33.,
     *42.,40.,44.,44.,43.,45.,45.,45.,43.,41.,37.,34.,52.,51.,54.,54.,
     *54.,56.,55.,53.,54.,52.,56.,55.,53.,2*0.,42.,37.,35.,49.,49.,37./
      DATA (XVU1(J),J=394,509)/
     *61.,51.,60.,59.,56.,54.,53.,51.,51.,50.,49.,48.,56.,52.,54.,50.,
     *36.,34.,36.,40.,39.,44.,43.,41.,39.,37.2,3*0.,51.7,50.3,37.2,36.2,
     *34.9,39.7,36.3,48.7,46.7,65.4,64.4,51.0,50.1,45.2,45.2,54.1,49.5,
     *57.4,48.8,56.5,54.1,60.,50.,49.3,50.6,54.1,57.2,54.2,45.7,44.4,
     *44.9,49.8,67.7,58.5,60.5,60.0,58.5,37.9,65.1,48.4,46.6,56.5,61.3,
     *54.9,55.9,61.9,60.4,58.2,46.6,42.6,46.6,42.8,59.5,73.5,61.3,65.4,
     *46.5,48.4,26.5,25.4,43.1,54.1,54.1,54.1,54.1,54.1,54.1,39.8,38.0,
     *38.6,33.2,33.9,38.3,36.6,39.8,39.8,39.6,39.6,30.6,33.2,33.2,33.7,
     *20.7,21.4,41.4,40.3,47.1/
      DATA (XVF1(J),J=1,390)/
     1           14*0.,35.,12*0.,75.,27*0.,46.,2*0.,40.,0.0,52.,53.,3*0.,
     *78.,10*0.,25.,54.,53.,52.,52.,0.0,48.,3*0.,24.,94.,94.,92.,60.,
     *56.,67.,29.,0.0,29.,64.,33.,36.,24.,5*0.,36.,30.,31.,24.,33.,33.,
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*27.,0.0,22.,25.,70.,17.,22.,48.,93.,18.,13.,11.,8.6,5.6,16.,14.,
*10.,9.0,7.9,12.,13.,8.6,14.,12.,0.0,12.,20.,26.,21.,17.,14.,3*0.,
*17.,28.,28.,19.,19.,11*0.,22.,23.,23.,25.,0.,27.,15.,27.,2*0.,27.,
*                 27.,3*0.,23.,24.,20.,19.,29.,14.,17.,24.,27.,29.,
*2*0.,25.,27.,31.,30.,0.,2*32.,27.,3*32.,2*0.,36.,35.,30.,34.,
*40.,35.,37.,35.,35.,2*0.,68.,0.0,68.,0.0,63.,68.,68.,68.,68.,7*0.,
*66.,66.,0.0,68.,68.,63.,68.,68.,27.,68.,68.,69.,69.,65.,0.0,61.,
*66.,65.,0.0,68.,65.,50.,38.,28.,52.,65.,66.,37.,37.,37.,37.,41.,
*52.,53.,61.,69.,68.,57.,52.,71.,0.0,63.,63.,46.,51.,73.,0.0,73.,
*73.,0.0,127.,127.,98.,93.,78.,63.,51.,52.,53.,56.,54.,0.0,121.,
*54.,73.,61.,61.,53.,53.,37.,57.,57.,0.0,42.,16.,16.,49.,55.,66.,
*68.,68.,68.,68.,68.,0.0,63.,55.,28.,28.,19.,19.,19.,19.,18.,24.,
*24.,23.,24.,24.,24.,31.,43.,50.,57.,31.,44.,57.,50.,58.,50.,50.,
*50.,50.,50.,49.,50.,49.,50.,51.,51.,50.,49.,49.,51.,51.,51.,49.,
*51.,51.,60.,51.,52.,51.,52.,51.,52.,52.,49.,50.,49.,49.,49.,60.,
*60.,60.,60.,60.,61.,61.,61.,61.,61.,60.,60.,60.,2*0.,46.,46.,46./
 DATA (XVF1(J),J=391,509)/
*60.,60.,59.,71.,71.,71.,71.,71.,71.,71.,71.,69.,61.,50.,69.,66.,
*65.,65.,65.,54.,55.,55.,55.,54.,54.,54.,55.,55.,54.3,3*0.,54.3,
*54.3,53.5,53.5,54.7,54.7,54.7,58.2,58.5,74.0,73.5,64.5,60.4,59.8,
*59.8,50.8,53.4,59.7,53.4,53.4,53.4,53.4,57.4,57.4,66.6,66.6,65.7,
*66.6,68.2,65.1,65.1,40.9,68.2,66.6,66.3,64.1,62.3,66.3,66.9,68.8,
*68.8,68.8,68.8,65.7,65.7,65.7,68.8,68.8,52.8,52.6,52.5,52.6,77.9,
*81.7,83.2,70.0,52.8,53.7,35.1,34.9,65.1,64.1,62.6,64.1,63.1,63.8,
*63.8,43.4,43.4,41.4,40.8,40.0,43.4,43.4,44.8,44.8,43.4,43.4,38.3,
*37.3,38.3,31.2,17.2,21.7,27.4,39.2,53.2/
 DATA(XTU1(J),J=1,383)/
*            14*0.,70.,12*0.,70.,29*0.,69.,2*0.,70.,0.0,67.,65.,3*0.,
*70.,10*0.,70.,68.,70.,70.,70.,0.0,70.,3*0.,67.,67.,70.,70.,60.,
*45.,45.,45.,0.0,45.,80.,75.,79.,78.,5*0.,70.,70.,70.,65.,65.,70.,
*70.,0.0,70.,70.,70.,70.,70.,70.,70.,75.,71.,71.,72.,72.,40.,42.,
*2*42.,2*45.,47.,63.,54.,55.,0.0,61.,63.,66.,70.,70.,70.,3*0.,72.,
*68.,67.,62.,63.,11*0.,69.,67.,66.,47.,0.0,40.,40.,43.,2*0.,54.,
*57.,3*0.,56.,76.,77.,81.,85.,95.,107.,77.,91.,86.,2*0.,96.,104.,
*94.,100.,0.0,76.,106.,91.,93.,64.,62.,2*0.,52.,76.,91.,110.,102.,
*105.,121.,121.,121.,2*0.,108.,0.0,93.,0.0,123.,117.,103.,119.,
*119.,7*0.,79.,85.,0.0,118.,84.,71.,63.,66.,72.,63.,115.,146.,117.,
*44.,0.0,39.,51.,51.,0.0,58.,62.,65.,68.,77.,106.,126.,124.,93.,
*94.,74.,79.,92.,90.,90.,84.,83.,81.,78.,77.,138.,0.0,106.,120.,
*117.,114.,70.,0.0,70.,70.,0.0,69.,69.,84.,54.,54.,54.,55.,62.,62.,
*96.,106.,0.0,60.,60.,59.,57.,57.,52.,53.,53.,53.,55.,0.0,37.,43.,
*39.,32.,58.,58.,70.,60.,66.,53.,53.,0.0,48.,45.,48.,45.,55.,57.,
*58.,50.,50.,63.,58.,46.,47.,47.,48.,64.,63.,63.,61.,64.,63.,61.,
*86.,108.,108.,100.,99.,103.,80.,78.,76.,78.,83.,90.,94.,70.,68.,
*66.,50.,47.,50.,50.,50.,48.,57.,55.,55.,53.,60.,60.,60.,76.,68.,
*70.,65.,63.,55.,63.,63.,63.,63.,65.,68.,104.,114.,114.,111.,65./
 DATA(XTU1(J),J=384,509)/
*88.,76.,2*0.,48.,48.,48.,48.,48.,55.,56.,45.,38.,63.,71.,79.,78.,
*83.,83.,98.,97.,99.,63.,63.,63.,63.,76.,89.,87.,83.,94.,98.,101.,
*109.,102.,102.,3*0.,109.,103.,75.,64.5,79.0,104.,106.,68.,81.,
*92.5,97.5,101.,96.,72.5,68.0,99.0,94.0,97.5,91.,107.,114.,108.,
*114.,116.,108.,104.,106.,104.,101.,97.5,91.,114.,122.,129.,135.,
*131.,137.,61.5,62.5,62.5,67.0,66.0,67.0,46.5,48.0,108.0,114.0,
*111.0,96.0,64.5,63.0,59.5,68.0,68.0,61.0,59.5,68.0,88.0,128.0,
*135.0,51.5,51.5,57.5,54.5,56.0,56.0,56.0,62.5,51.5,64.5,56.0,56.0,
*56.0,56.0,56.0,58.0,56.0,56.0,62.5,64.5,66.0,64.5,72.0,72.0,71.0,
*68.0,68.0/
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      DATA (XTF1(J),J=1,381)/
     *            14*0.,70.,12*0.,70.,29*0.,69.,2*0.,70.,76.,70.,68.,3*0.,
     *70.,10*0.,70.,68.,70.,70.,70.,0.0,70.,3*0.,63.,67.,70.,70.,60.,
     *45.,45.,45.,0.0,45.,80.,80.,83.,82.,5*0.,95.,95.,95.,65.,65.,110.,
     *105.,0.0,105.,80.,80.,80.,80.,80.,80.,75.,72.,72.,72.,72.,50.,52.,
     *52.,52.,52.,50.,50.,62.,54.,55.,0.0,61.,63.,70.,70.,70.,70.,3*0.,
     *92.,68.,59.,65.,63.,11*0.,3*73.,59.,0.0,52.,58.,58.,2*0.,64.,
     *65.,3*0.,63.,81.,82.,87.,93.,101.,96.,91.,91.,90.,2*0.,103.,113.,
     *99.,104.,0.0,94.,76.,101.,108.,77.,77.,2*0.,64.,84.,95.,107.,108.,
     *110.,110.,116.,118.,2*0.,118.,0.0,101.,0.0,121.,122.,110.,114.,
     *114.,7*0.,67.,72.,0.0,118.,103.,90.,93.,85.,82.,67.,117.,127.,
     .122.,54.,0.0,41.,62.,60.,0.0,70.,74.,76.,77.,86.,103.,120.,120.,
     *104.,99.,84.,88.,97.,97.,97.,93.,93.,88.,86.,86.,129.,0.0,111.,
     *124.,120.,117.,70.,0.0,70.,70.,0.0,74.,73.,98.,74.,86.,86.,86.,
     *57.,55.,101.,71.,0.0,62.,64.,53.,54.,55.,41.,40.,41.,41.,43.,0.0,
     *37.,42.,44.,32.,59.,59.,78.,66.,61.,55.,55.,0.0,51.,51.,51.,51.,
     *55.,59.,61.,51.,51.,72.,51.,48.,55.,53.,53.,61.,64.,64.,63.,61.,
     *64.,66.,89.,97.,117.,107.,107.,118.,81.,81.,76.,80.,83.,91.,91.,
     *72.,72.,70.,49.,47.,49.,51.,51.,47.,53.,55.,53.,53.,63.,63.,63.,
     *80.,70.,69.,64.,63.,55.,64.,64.,54.,64.,82.,89.,82.,105.,107./
      DATA (XTF1(J),J=382,509)/
     *110.,66.,78.,78.,2*0.,51.,51.,51.,52.,52.,60.,62.,53.,45.,62.,70.,
     *76.,84.,87.,99.,103.,108.,48.,66.,66.,66.,66.,85.,95.,97.,89.,
     *105.,108.,110.,116.,116.,116.,3*0.,112.,114.,89.,81.5,81.9,108.,
     *114.,75.,93.,101.,106.,114.,106.,86.5,77.5,105.,112.,
     *102.,97.,116.,125.,108.,122.,128.,122.,114.,116.,118.,106.,108.,
     *105.,132.,134.,137.,144.,144.,147.,64.,66.,66.,64.,69.5,64.,52.5,
     *52.5,110.,116.,119.,92.,72.,70.,62.,64.,64.,66.,66.,71.5,64.,
     *132.,141.,60.5,60.5,60.5,58.5,58.5,58.5,58.5,62.5,56.5,60.,60.,
     *62.,64.5,66.,66.,66.,64.5,66.,74.,69.,74.,74.,92.,72.,71.,
     *70.,68.0/
      DATA(XMR1(J),J=1,338)/
     *            14*0.,.99,12*0.,.84,29*0.,1.78,2*0.,1.50,1.95,1.14,1.21,
     *3*0.,1.29,10*0.,1.11,1.09,0.91,0.02,1.08,0.0,1.02,3*0.,1.10,0.82,
     *      0.82,1.02,1.04,1.31,1.31,1.08,0.0,1.11,0.89,0.84,0.80,1.10,
     *5*0.,1.69,2.01,1.18,1.38,1.16,1.04,0.96,0.0,0.96,0.96,1.07,1.23,
     *1.12,1.09.1.06,1.16,0.95,0.89,0.90,1.10,1.11,0.96,1.18,1.27,1.83,
     *1.19,1.00,0.71,1.17,1.04,0.0,1.13,0.98,1.20,1.22,1.07,1.18,3*0.,
     *1.71,1.21,1.20,1.22,1.01,11*0.,1.07,1.44,1.47,1.35,0.0,1.31,1.45,
     *1.25.2*0.,1.20,1.20,3*0.,1.30,1.55,1.23,1.47,0.94,1.83,1.41,1.31.
     *1.41,1.24,2*0.,1.42,1.27,1.14,1.13,0.0,1.09,0.72,1.25,1.03,1.04,
     *0.92,2*0.,1.23,1.36,1.59,1.23,0.99,1.19,1.12,1.24,1.24,2*0.,1.17,
     *0.0,1.17,0.0,1.27,1.13,1.24,1.16,1.52,7*0.,1.10,1.18,0.0,1.12,
     *1.05,1.08,1.18,1.05,1.19,1.37,1.56,1.14,1.14,0.87,0.0,1.31,1.25,
     *1.34,0.0,1.29,1.23,1.28,1.29,1.33,1.32,1.26,1.20,1.22,1.22,1.24,
     *1.18,1.18,1.10,1.24,1.17,1.16,1.22,1.44,1.49,0.97,0.0,1.28,1.31,
     *1.70,1.17,1.45,0.0,1.19,1.29,0.0,1.13,1.54,1.22,1.16,1.16,1.14,
     *1.25,1.69,1.32,1.03,1.13,0.0,1.09,1.24,1.44,1.15,1.23,1.20,0.93,
     *1.11,1.16,1.07,0.0,1.04,1.00,1.26,1.58,1.30,1.25,1.25,1.25,1.25,
     *1.25,1.29,0.0,1.44,1.45,1.15,1.36,1.40,1.40,1.29,1.46,1.57,1.37,
     *1.30,1.30,1..[illegible],1.27,1.27,1.24,1.11,1.13,0.82,1.23,1.11,0.89,1.24/
      DATA(XMR1(J),.=339,509)/
     *1.11,1.05,1.16,1.21,1.16,1.24,1.26,1.28,1.25,0.91,0.93,1.12,1.35,
     *1.21,1.23,1.19,1.23,1.03,1.21,1.19,1.19,.079,1.02,1.12,1.23,1.23,
     *1.22,1.25,1.25,1.29,1.24,1.21,1.06,0.98,1.23,1.19,1.27,1.29,1.27,
     *1.31,1.29,1.28,1.27,1.21,1.32,1.29,1.26,2*0.,1.29,1.13,1.71,1.17,
     *1.16,0.881,1.21,1.02,1.20,1.19,1.35,1.09,1.06,1.02,1.60,1.16,1.16,
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     *,993,1.02,1.14,1.11,1.09,.946,.877,.919,1.03,1.01,1.14,1.13,1.05,
     *0.95,0.98,3*0.,1.35,1.32,0.99,0.97,0.91,1.04,0.95,1.19,1.14,1.26,
     *1.23,1.20,1.18,1.08,1.08,1.52,1.32,1.37,1.30,1.58,1.45,1.60,1.24,
     *1.24,1.08,1.16,1.16,1.16,1.13,0.97,0.98,1.00,1.41,1.25,1.29,1.33,
     *1.34,.814,1.34,1.00,0.96,1.17,1.26,1.19,1.21,1.35,1.25,1.21,1.26,
     *1.15,1.26,1.16,1.09,1.28,1.05,1.33,1.25,1.28,1.06,1.03,0.946,1.20,
     *1.23,2.51,1.22,1.21,1.21,1.31,1.25,1.37,1.16,1.16,1.26,1.21,1.27,
     *1.27,1.31,1.31,1.14,1.27,1.23,1.54,1.71,1.40,2.20,1.48,1.27/
      DATA (XMOM1(J),J=1,339)/
     *          14*0.,1.62,12*0.,2.05,29*0.,0.47,2*0.,0.64,0.38,1.10,
     *1.02,3*0.,0.86,10*0.,1.16,1.22,1.75,1.70,1.20,0.0,1.08,3*0.,1.18,
     *2.18,2.18,1.38,1.31,0.83,0.83,1.23,0.0,1.17,1.80,2.20,2.28,1.20,
     *5*0.,0.41,0.41,1.06,0.76,1.07,1.33,1.59,0.0,1.58,1.58,1.28,0.95,
     *1.15,1.21,1.28,1.06,1.06,1.81,1.77,1.17,1.15,1.56,1.01,0.88,0.43,
     *1.00,1.92,2.81,1.05,1.54,0.0,1.11,1.47,0.99,0.95,1.25,1.03,3*0.,
     *0.49,0.97,0.98,1.29,1.40,11*0.,1.25,0.69,0.65,0.79,0.0,0.84,0.68,
     *0.92,2*0.,0.99,0.99,3*0.,0.84,1.07,0.94,0.66,1.61,0.43,0.72,0.84,
     *,72,.92,2*0.,.71,.89,1.1,1.12,0.0,1.21,2.79,.92,1.36,1.32,1.68,
     *2*0.,0.95,1.36,1.59,1.23,1.44,0.99,1.13,0.93,0.93,2*0.,0.85,0.0,
     *0.65,0.0,0.79,0.88,0.81,0.86,0.80,7*0.,1.18,1.00,0.0,0.88,0.95,
     *0.92,0.84,0.95,1.00,0.76,0.59,1.11,1.11,1.89,0.0,0.82,0.92,0.79,
     *0.0,0.89,0.94,0.87,0.85,0.59,0.82,0.92,0.98,0.95,0.84,0.92,1.01,
     *1.04,1.18,0.93,1.03,0.86,0.95,0.68,0.67,1.52,0.0,0.87,0.82,0.49,
     *1.03,0.68,0.0,0.98,1.16,0.0,1.12,0.87,0.94,1.06,1.06,1.06,0.92,
     *0.60,0.82,0.78,1.09,0.0,1.20,0.94,0.78,1.09,1.01,0.96,1.59,1.05,
     *1.05,1.74,0.0,1.41,1.27,0.80,0.59,0.86,0.86,1.17,1.17,0.80,0.80,
     *0.80,0.0,0.70,0.71,1.09,0.77,0.76,0.76,0.82,0.70,0.62,0.78,0.85,
     *0.84,0.83,0.90,0.90,0.92,1.16,1.12,2.08,1.57,1.15,1.78,0.94,1.16/
      DATA (XMOM1(J),J=340,509)/
     *1.31,1.06,0.99,1.06,0.81,0.90,0.88,0.92,1.72,1.64,1.13,7.82,0.98,
     *0.938,1.02,0.93,1.35,0.97,1.02,1.02,1.02,1.19,1.14,0.93,0.95,0.96,
     *0.92,0.93,0.85,0.93,0.98,1.23,1.45,1.03,0.99,0.79,0.85,0.88,0.83,
     *0.86,0.93,0.88,1.08,0.81,0.99,0.91,2*0.,0.848,1.10,0.484,1.04,
     *1.06,1.64,.967,1.37,.991,1.52,.931,1.19,1.24,1.36,1.32,1.05,.882,
     *1.44,0.98,1.09,1.08,1.21,1.62,1.85,1.69,1.34,1.39,1.09,1.11,1.13,
     *1.43,1.49,3*0.,0.78,0.82,1.45,1.15,1.72,1.33,1.59,1.00,1.10,0.89,
     *0.91,1.06,1.02,1.23,1.23,0.62,0.81,0.76,0.84,0.58,0.68,0.55,0.93,
     *0.96,1.22,1.06,1.06,1.06,2.57,1.51,1.47,1.43,.712,.913,.852,.801,
     *,797,2.15,.789,1.42,1.54,1.04,0.89,1.00,0.97,0.79,0.91,0.98,0.90,
     *1.07,0.90,1.06,1.20,0.87,1.29,.807,.905,0.86,1.24,1.33,1.60,.986,
     *,938,.471,.952,.970,.970,.830,.910,0.7?,1.06,1.04,0.90,0.98,0.89,
     *0.89,0.83,0.83,1.09,0.88,0.93,.598,.488,.721,.296,00.65,0.89/
C
C
C                 INVESTIGATUR *** NURICK *** ( INV=2 ) *******
C
      DATA XPL2 /8*0.0,22*13.7,0.00,2*13.7,10*0.0,4*13.7,5*0.0,
     1           235.,225.,225.,220./
      DATA XVU2/
     0           8*0.0,4*33.0,3*30.0,2*28.0,30.0,32.0,2*33.0,38.0, 51.0,
     1           2*47.0,46.0,41.6,40.3,40.5,42.3,00.0,41.3,39.2,10*0.0,
     2           38.0,40.2,40.2,40.2,5*0.0,2*39.8,2*40.4/
      DATA XVF2/
     1           8*0.0,2*43.0,2*41.0,2*36.0,40.0,41.0,5*43.0,50.0,63.0,
     2           2*56.0,54.0,56.2,51.9,51.9,48.5,00.0,50.1,49.2,10*0.00,
     3           52.0,51.3,51.6,51.4,5*0.0,64.5,55.0,53.0,52.0/
      DATA XTU2 /
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ORIGINAL PAGE IS
OF POOR QUALITY

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     1        8*0,0,3*55,0,52,0,9*55,0,5*45,0,4*40,0,0,0,2*40,0,10*0,,
     2        4*40,0,5*0,0,4*40,0/
      DATA XTF2 /
     1        8*0,0,60,0,62,0,50,0,67,0,3*55,0,6*65,0,5*55,0,4*40,0,
     2        000,0,2*40,0,10*0,0,4*50,0,5*0,0,4*45,0/
      DATA XMR2 /56*0,0/
C
      DATA XMUM2/
     1        8*0,0,2*0,86,0,91,0,93,2*1,00,0,85,0,69,0,63,0,83,0,88,
     2        2*0,91,0,85,0,94,2*1,00,1,03,1,26,1,15,1,14,0,90,0,00,
     3        1,02,1,09,10*0,0,1,28,1,04,1,05,1,04,5*0,0,1,5,1,1,0,99,
     4        0,96/
      DATA ICOM2/
     1        8*0,15*3,3*1,4*3,0,2*3,10*0,4*3,5*0,4*3/
      DATA IFUEL2/ 43*1,13*2/
C
      DATA IMP2 /
     1        8*0,0,13*45,,9*60,,0,0,2*60,,10*0,0,4*60,,5*0,,4*60,/
      DATA XDL2 /
     1        8*0,0,13*0,173,2*0,072,3*0,030,4*0,173,0,000,2*0,173,
     2       10*0,0,4*0,173,5*0,0,4*0,173/
      DATA XDF2 /
     1        8*0,0,13*0,173,2*0,072,3*0,030,4*0,173,0,000,2*0,173,
     2       10*0,0,4*0,173,5*0,0,4*0,173/
C
C                 INVESTIGATOR *** HOUSEMAN *** INV = 3 ***
C
      DATA ICUM3 /
     1         2*3,1,2*3,1,3,1,3,3,2*1,3,1,8*3,1,3*3,1,2*3,1,3,3,3*3,
     2         1,3*3,4*1,2*3,2*1,9*3,2*1,3/
      DATA XPC3 /
     1        14,2,16,0,42,0,14,2,18,0,56,0,14,2,23,0,73,0,14,2,29,0,
     2        14,2,52,0,120,,14,2,28,0,68,0,14,2,19,0,42,0,110,,14,2,
     3        23,0,52,0,154,,14,2,35,0,250,,54,0,118,,14,2,450,,14,2,
     4        94,0,250,,4*28,0,5*43,0,5*52,0,3*70,0,4*100,,3*120,/
      DATA XVU3 /
     1         38,2,36,1,36,8,46,3,45,1,46,3,58,2,55,9,60,8,73,0,70,8,
     2        127,8,123,9,115,2,19,1,19,8,19,0,28,5,29,6,27,9,28,3,
     3   37,3,  38,6,39,9,37,8,66,3,62,9,63,2,117,4,145,0,40,0,32,3,
     4      21,6,20,5,18,7,71,0,24,0,20,,5,4,60,,37,,28,,28,,8,0,124,0,
     5         44,0,40,0,40,0,10,0,61,0,51,0,20,,91,0, 80,0,21,0,16,0,
     6         115,0,145,0,17,0/
      DATA XDU3 /
     1        14*0,073,16*,100,7*0,073,0,100,,173,2*0,073,2*0,100,
     2        0,173,2*0,073,2*0,100,0,173,0,073,2*0,100,0,073,0,100,
     3        2*0,173,0,073,0,100,0,173/
      DATA IMP3/59*45,0/
      DATA XMR3 /59*1,20/
      DATA IFUEL3/59*1/
      DATA XMUM3/59*1,0/
      DATA XTU3 / 59*70,0/
C
C
C     **********   INVESTIGATOR *** LAWYER *** ( INV=4 ) *************
C
C                  TEST DATA (A-AREA)
C
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 DATA ICOM4/
1           10*2,1,3*1,6*2,1,5*2,5,2,2,5,2*1,4,5,5,3*2,3*4,1,2*4,
2           3*2,2*1,3*2,3*6,1,1,5*6,6*1,4,1,1,6,6,1,5,6*1,3*2,4,2*1,        *NEW
35,2,1,1,3*5,2,2,1,6,4,5*1,6,1,2,3*1,5*4,2,2,4*1,2*2,2*1,                   **-1
48*2,5,0,5,1,12*2,2*5,3*1,2,1,5,3*2,14*0,6,3*1,5,2,                          6
53*1,5,2,2,1,3*6,1,5,5*2/                                                    6
 DATA XPC4 /
1           308.,308.,309.,311.,507.,1000.,308.,263.,197.,158.,100.,
2           89.,101.,162.,203.,269.,301.,310.,510.,1003.,160.,338.,
3           334.,955.,495.,298.,283.,256.,191.,152.,95.,114.,411.,
4           97.,119.,150.,188.,243.,103.,2*81.,119.,129.,154.,152.,
5           190.,258.,102.,99.,297.,484.,958.,98.,100.,102.,107.,
6           102.,101.,99.,101.,2*102.,98.,100.,2*95.,2*99.,95.,89.,
7           95.,196.,198.,201.,192.,3*97.,97.,202.,295.,182.,196.,
8           259.,269.,262.,293.,300.,295.,99.,98.,98.,99.,99.,202.,
9           2*202.,92.,94.,89.,97.,81.,102.,95.,201.,199.,193.,295.,
A           291.,293.,290.,290.,289.,293.,292.,489.,491.,135.,124.,
B           98.,81.,148.,194.,122.,123.,122.,122.,144.,119.,122.,
C           146.,145.,124.,123.,0.,102.,81.,144.,186.,164.,160.,166.
D           ,192.,123.,117.,119.,139.,137.,147.,129.,125.,99.,80.,
E       146.,194.,119.,116.,113.,131.,137.,14*0.,126.,129.,101.,81.,
F           157.,210.,129.,129.,132.,130.,156.,150.,124.,98.,78.,78.
G           ,147.,198.,123.,123.,121.,145.,144./
 DATA XTU4 /
1           4*88.,2*89.,86.,2*84.,83.,84.,76.,88.,82.,81.,80.,78.,
2           81.,82.,82.,81.,81.,77.,82.,2*83.,84.,4*85.,86.,83.,77.,
3           78.,77.,76.,79.,61.,64.,66.,68.,2*67.,4*68.,69.,2*70.,
4           78.,55.,2*54.,2*53.,58.,5*57.,3*56.,2*55.,7*44.,50.,48.,
5           47.,64.,66.,67.,75.,76.,71.,70.,69.,68.,70.,73.,64.,62.,
6           71.,78.,80.,82.,124.,112.,53.,74.,65.,68.,69.,72.,70.
7           ,66.,77.,80.,70.,63.,61.,62.,78.,76.,75.,71.,68.,68.,65.
8           ,72.,69.,62.,76.,79.,77.,80.,93.,116.,127.,109.,120.,
9            136.,162.,153.,73.,0.,71.,74.,78.,79.,74.,77.,2*78.,79.
A           ,85.,136.,132.,153.,154.,73.,70.,68.,72.,72.,71.,77.,76.
B       ,140.,120.,155.,14*0.,59.,78.,3*71.,72.,80.,2*85.,130.,131.,
C           145.,72.,73.,75.,74.,75.,76.,75.,80.,116.,131.,152./
 DATA XTP4 /
1           4*87.,2*88.,85.,2*84.,2*83.,76.,87.,82.,78.,77.,76.,81.,
2           82.,81.,2*80.,77.,82.,81.,82.,81.,2*83.,82.,2*83.,83.,
3           197.,3*199.,195.,59.,62.,64.,6*67.,68.,3*69.,74.,56.,
4           55.,3*54.,6*58.,3*57.,2*55.,7*44.,50.,2*48.,68.,71.,73.,
5           78.,77.,3*70.,69.,70.,72.,82.,93.,149.,177.,200.,196.,
6           178.,89.,60.,85.,75.,73.,74.,72.,70.,68.,69.,81.,74.,63.
7           ,64.,68.,84.,79.,77.,75.,70.,68.,70.,73.,71.,68.,75.,97.
8           ,141.,164.,229.,242.,249.,245.,268.,280.,291.,285.,76.,
9       0.,72.,76.,82.,79.,74.,79.,71.,75.,170.,239.,288.,283.,288.,
A       287.,2*75.,2*78.,76.,69.,178.,244.,312.,300.,301.,14*0.,71.,
B           77.,80.,77.,75.,73.,150.,226.,250.,287.,296.,297.,82.,
C           72.,76.,2*75.,76.,185.,249.,240.,290.,294./
 DATA XMH4 /
1           1.66,1.57,1.62,1.62,1.70,1.57,1.7,1.65,1.64,1.6,1.6,
2           1.59,1.63,1.66,1.65,1.67,1.64,1.6,1.64,1.63,1.62,1.65,
3           1.65,1.61,1.6,1.59,2*1.58,1.6,1.56,1.57,1.58,1.66,1.74,
4           1.72,2*1.74,1.6,1.455,1.61,1.6,1.59,1.42,1.53,1.62,1.57,
5           1.61,1.49,1.6,1.62,1.64,1.62,1.37,1.66,1.7,1.52,1.61,
6           1.94,1.68,1.65,1.54,1.82,1.63,1.65,1.61,3*1.63,1.66,1.62
7           ,1.63,1.84,1.66,1.62,3*1.63,1.65,1.67,1.7,1.6,2*1.62,
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      8          1.57,1.64,1.51,1.69,1.58,1.57,2*1.64,1.69,1.7,1.73,1.77,
      9          2*1.69,1.64,1.58,1.6,1.59,1.61,2*1.63,1.91,1.67,1.61,1.6
      A          ,1.57,1.62,1.47,1.61,2*1.6,1.59,2*1.6,1.67,1.7,1.63,1.66
      B          ,1.69,1.71,1.77,1.8,1.82,1.81,1.8,2*1.75,1.76,1.72,1.69,
      C          1.68,0.,1.69,2*1.68,1.65,1.64,1.66,1.67,1.64,2*1.72,1.7,
      D          3*1.69,2.15,2.37,2.33,2.41,2.13,2.28,2.23,2.27,1.90,2.31
      E  ,2.3,14*0.,1.76,1.66,1.67,1.84,1.63,2*1.64,1.66,1.68,1.66,1.67,
      F          1.66,1.63,1.62,1.54,1.62,1.66,1.65,1.68,1.74,1.65,1.71,
      G          1.65/
       DATA IMP4 /
      1          11*60.,12*60.,9*60.,6*60.,14*60.,26*60.,19*60.,20*60.,
      2          16*.1,16*90.,11*32.,14*0.,12*32.,11*60./
       DATA XDU4 /
      1          11*.024,12*.024,9*.024,6*.024,14*.024,26*.024,19*.024,
      2          20*.024,16*.024,16*.024,11*.0495,14*0.,12*.0336,11*.024/
       DATA XDF4 /
      1          11*.02,12*.02,9*.02,6*.02,14*.02,26*.02,19*.02,20*.02,
      2          16*.021,16*.021,11*.0295,14*0.,12*.02,11*.02/
       DATA XHO4/,0252,.0245,.0249,.0246,.0252,.0256,.025,.0242,.0265,
      2          .0246,.0258,.0144,.0255,.0239,.0255,.0234,.0173,.0243,
      3          .024,.0246,.0249,.0204,.0212,.0195, 2*.0248,.015,.0237,
      4          .0256,.024,.0248,.0255,.0352,.0261,.0264,.026,.0275,
      5          .0262,.0102,.0277,.0275,.0259,.0092,.0102,.025,.0256,
      6 .024,.0105,.0254,.0255,.0270,.0286,.00831,.00843,.01056,.01416,           *NEW
      7 .01537,.00826,.00868,.01121,.01083,.01184,.01674,.01434,.02072,           *NEW
      8 .02637,.01469,.01478,.01523,.03254,.03212,.01295,.01278,.01534,           *NEW
      9           .02055,.01505,.01508,.01456,.01485,.01403,.01431,.03066         *NEW
      0          ,.02889,.02041,.01948,.01428,.01254,.01526,.02531,.01442         **-4
      A          ,.0148,.01465,.01448,.01487,.01398,.01339,.01345,.0105,
      B          .0128,.0143,.0149,.0226,.0255,.0315,.0117,.0145,.032,
      C          .0127,.0124,.012,.0122,.0151,.0209,.0256,.0319,.0205,
      D          .0263,.0125,.0142,.0113,.0093,.0168,.0222,.01422,.0144,
      E          .0142,.0141,.0165,.0145,.0141, 2*.0166,.014,.0138,.0,
      F          .0107,.00896,.0168,.0225,.015,.0156,.015,.0222,.014,
      G          .0144,.01399,.0169,.01699,.0161,.0578,.0598,.0464,.0381,
      H    .0698,.0921,.0623,.0644,.0641,.0752,.072,14*0.,.0282,.0259,.02
      I        ,.0164,.03,.04,.0266,.0267, 2*.0259,.0308,.0318,.0139,.0111
      J    ,.00916,.00937,.0166,.0222, 2*.0143,.0144,.0173,.0175/
       DATA XWF4/,0152,.0156,.0153,.0152,.0148,.0163,2*.0147,.0161,.0153,
      2          .016,.00905,.0156,.0144,.0154,.014,.0105,.0151,.0147,
      3          .015,.0153,.0123,.0128,.012,.0154,.0156,.00952,.0149,
      4          .016,.0153,.0157,.0161,.0212,.015,.0153,.015,.0158,.0164
      5         ,.007,.0171,.0171,.0163,.00646,.00654,.0153,.0162,.0148,
      6 .007,.0159,.0157,.0164,.0176,.00604,.00503,.00617,.00926,.00951,          *NEW
      7 .00427,.00515,.00678,.00698,.00647,.0102,.00864,.0128,.0161,.0089         *NEW
      8 ,.00897,.00907,.0198 ,.01945,.00695,.00758,.00937,.01243,.00911,          *NEW
      9 .00897,.00878,.00893,.00826,.00892,.01685,.01784,                         *NEW
      U .01296,.01187,.00944,.00744,.00963,                                       *NEW
      A          .01611,.0088,.00903,.00867,.00851,.00862,.00791,.0079,           **-5
      B.00796,.00637,.00811,.00891,.00938,.014,.0156,.0193,.00611,.00867,
      C.0198,.00792,.0079,.00739,.00829,.00934,.013,.016,.02,.0128,.0164,
      D.00745,.00832,.0069,.00559,.00995,.013,.00802,.00778,2*.0078,.0091
      E4,.00829,.00806,.00945,.00963,.00826,.0082, 0.,.00632,.00533,.01,
      F.0136,.00917,.00938,.00897,.0135,.00818,.00838,.00821,2*.01,.00953
      G,.0268,.0252,.0199,.0156,.0327,.0403,.0279,.0283,.0336,.0327,.0312
      H,14*0.,.016,.0156,.0119,.00917,.0184,.0244,.0162,.016,.0154,.0155,
      I.0184,.0192,.00857,.00684,.00594,.00576,.01,.0135,.0085,.00827,
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     J,00875,.01011,.0106/
      DATA IFUEL4/
     1          11*3,12*2,9*3,6*3,14*3,26*3,19*3,20*2,16*3,16*3,11*3,
     2          1?*0,12*3,11*3/
      DATA SPACE4/
     1          11*24.,12*24.,9*24.,6*24.,14*24.,26*24.,19*24.,20*24.,
     2          16*.1,16*.1,11*4.,14*0.,12*4.,11*24./
      DATA TIMP4/
     1          41*0.,268.,148.,145.,249.,265.,393.,182.,230.,748.,
     2          1009.,1416.,171.,213.,224.,2*140.,229.,194.,203.,189.,
     3          203.,152.,142.,129.,136.,2*120.,119.,146.,150.,120.,111.,
     4          ,115.,160.,133.,130.,117.,136.,181.,201.,207.,206.,211.,
     5          211.,171.,164.,178.,212.,143.,142.,189.,204.,218.,250.,
     6          247.,204.,171.,174.,184.,216.,219.,221.,225.,240.,252.,
     7          283.,0.,0.,0.,340.,475.,361.,409.,454.,873.,830.,284.,
     8          282.,254.,233.,304.,320.,299.,301.,311.,0.,0.,318.,310.,
     9          326.,331.,315.,271.,0.,268.,254.,0.,0.,263.,261.,260.,
     A          309.,283.,302.,317.,327.,331.,331.,11*0.0,14*0.,12*0.0,
     B          11*0.0/
      DATA XAT4/4*.0855,.0552,.0275,2*.0855,2*.1466,3*.2489,2*.1466,      *NEW
     1          3*.0855,.0552,.0275,.1466,3*.0275,.0552,3*.0855,2*.1466,  *NEW
     2          2*.2489,.0552,2*.2489,2*.1466,.0855,4*.2489,4*.1466,      *NEW
     3      .0855,2* 2489,  .0855,.0552,.0275,2*.1466,3*.2489,2*.1466,    *NEW
     4          12*. 489,3*.0855,.1466,4*.2489,4*.0855,2*.0552,.0133,     *NEW
     5          3*.0 55,5*.2489,3*.0855,.0216,2*.0302,.0356,.0495,.0661,  *NEW
     6          .0871,.0131,.0177,.0430,4*.01,.0123,.0177,.0216,.0281,.01 *NEW
     7          ,.0131,.0216,31*.0281,11*.1046,14*1.,12*.0568,11*.0281/   *NEW
C
C
C     **********   INVESTIGATOR *** ROCKETDYNE *** ( INV=5 )   **********
C
C
      DATA ICUM5/
     1          8*0,2*1,6*0,9*1,4*0,4*1,0,2*1,2,1,2,3*0,1,0,1,2,0,1,3*2,
     2          1,0,2*2,1,2*0,2*2,2*0,2*2,0,2,4*1,3*0,3*1,5*0,4,3*1,4,
     3      7*1, 4*0,2*1,4,7*1,10*0,5*1,3*2,1,5*2,2*1,5*2,0,6*2/
      DATA XPC5/
     1          8*0.,63.,74.,6*0.,62.,61.,67.,69.,67.,114.,115.,166.,
     2          214.,4*0.,109.,119.,114.,171.,0.,69.,112.,117.,162.,185.
     3          ,3*0.,69.,0.,2*71.,0.,3*122.,62.,113.,0.,67.,114.,164.,
     4          2*0.,64.,113.,2*0.,64.,114.,0.,111.,62.,61.,104.,104.,
     5          3*0.,59.,106.,104.,5*0.,62.,104.,154.,3*53.,59.,2 64.,
     6          59.,2*62.,4*0.,25.,31.,51.,51.,74.,108.,113.,165.,34.,
     7          54.,10*0.,36.,51.,69.,109.,108.,160.,38.,45.,42.,51.,69.
     8          ,108.,106.,160.,38.,45.,37.,56.,69.,110.,106.,0.,40.,39.
     9          ,2*52.,71.,72./
      DATA XTU5/
     1          8*0.,50.,49.,6*0.,52.,50.,100.,114.,109.,84.,88.,104.,
     2          103.,4*0.,84.,81.,77.,76.,0.,2*74.,72.,73.,75.,3*0.,89.,
     3          0.,90.,89.,0.,84.,2*85.,97.,98.,0.,96.,101.,99.,2*0.,
     4          100.,98.,2*0.,2*99.,0.,110.,103.,99.,2*96.,3*0.,97.,92.,
     5          88.,5*0.,93.,86.,88.,101.,98.,97.,2*94.,97.,94.,102.,
     6          103.,4*0.,73.,74.,69.,71.,74.,73.,74.,71.,73.,71.,10*0.,
     7          89.,88.,89.,3*96.,97.,99.,96.,97.,2*98.,101.,100.,98.,
     8          101.,95.,98.,102.,103.,107.,0.,66.,55.,60.,54.,57.,53./
      DATA XTP5/
     1          6*0.,2*52.,6*0.,55.,56.,2*84.,86.,88.,90.,88.,92.,4*0.,
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     2      77.,109.,121.,95.,0.,115.,113.,136.,128.,136.,3*0.,114.,
     3      0.,117.,119.,0.,116.,125.,129.,124.,107.,0.,107.,121.,
     4      119.,2*0.,131.,147.,2*0.,164.,153.,0.,192.,2*95.,90.,96.
     5      ,3*0.,87.,92.,97.,5*0.,101.,110.,123.,110.,125.,137.,
     6      114.,132.,143.,137.,159.,172.,4*0.,2*78.,81.,76.,81.,78.
     7      ,79.,78.,90.,94.,10*0.,78.,81.,79.,78.,83.,82.,83.,84.,
     8      102.,116.,123.,130.,148.,140.,137.,143.,142.,142.,152.,
     9      155.,168.,0.,155.,169.,157.,172.,167.,175./
      DATA XMR5/
     1      8*0.,1.49,1.53,6*0.,1.75,1.94,1.75,1.79,1.66,1.68,1.65,
     2      1.5,1.57,4*0.,1.52,1.69,1.61,1.72,0.,2*1.66,1.82,1.84,
     3      1.69,3*0.,1.86,0.,1.51,1.94,0.,1.53,1.75,1.71,2.22,2.08,
     4      0.,2.41,2*2.29,2*0.,2.09,2.37,2*0.,2.22,2.36,0.,2.33,
     5      1.64,2.12,2.97,2.44,3*0.,2.23,2.22,2.44,5*0.,2.27,2.36,
     6     2.42,2*1.91,1.93,2.18,2*2.27,2.15,2.25,2.22,4*0.,1.61,1.84,
     7      1.54,1.56,1.73,1.78,1.76,1.61,1.76,1.79,10*0.,1.67,1.78,
     8      1.74,1.73,1.74,1.75,1.66,1.64,1.65,1.66,1.81,1.68,1.73,
     9      1.81,2*1.7,1.59,1.7,1.73,1.68,1.71,0.,1.65,1.66,1.81,
     A      1.84,1.72,1.73/
      DATA IMP5/
     1      145*60./
      DATA XDU5/
     1      42*.024,24*.04,27*.024,52*.04/
      DATA XDF5/
     1      42*.02,24*.033,27*.02,52*.033/
      DATA XVF5/
     1      8*0.,66.8,65.1,6*0.,48.5,44.3,56.1,57.8,73.2,54.5,71.6,
     2      50.1,46.5,4*0.,57.5,65.5,71 1,45.3,0.,70.9,56.1,71.7,
     3      50.5,69.9,3*0.,48.2,0.,58.5,65.5,0.,57.8,69.8,73.6,44.7,
     4      44.6,0.,54.4,57.,56.3,2*0.,47.1,60.4,2*0.,63.2,44.1,0.,
     5      62.1,54.8,59.4,34.1,53.9,3*0.,41.7,40.1,52.1,5*0.,42.9,
     6      39.7,38.2,47.4,47.8,48.1,43.2,2*41.,60.4,54.,54.3,4*0.,
     7      58.8,57.8,59.9,61.4,55.1,54.6,75.6,58.4,53.3,53.2,10*0.,
     8      57.8,54.8,57.4,54.3,77.1,53.5,56.7,77.6,55.4,56.9,54.3,
     9      55.3,74.1,50.9,52.,74.3,55.8,54.3,55.,54.9,75.5,0.,55.2,
     A      54.2,51.1,50.2,54.2,53.4/
      DATA SPACES/
     1      145*12./
      DATA IFUELS/
     1      145*3/
C
C     ********** INVESTIGATOR **** LANVER-OMS *** (INV=6) **********
C
      DATA ICUM6/5*2,2*5,2*1,5*2,5,3*1,5*2,18*4,2,5,
     1      10*2,5,4*2,4,6*2,5,5,4,4,5,4,4,5,5,47*4,2,2,5,4*2,4*2,
     2      5,1,2*2,4,2,5,1,7*2,6*4,11*2,8*4,2*2,4,4*5,2*2/
      DATA XPL6/ 120.,105.,115.,116.,133.,128.,127.,103.,81.,158.,132.,
     *      131.,130.,131.,116.,133.,103.,82.,159.,131.,2*130.,157.,
     2      127.,130.,101.,82.,151.,152.,130.,129.,130.,150.,129.,
     3      103.,82.,151.,124.,124.,125.,122.,126.,101.,81.,153.,
     4      124.,123.,123.,147.,114.,95.,127.,100.,80.,152.,100.,
     5      127.,126.,0.,126.,125.,148.,125.,125.,125.,81.,79.,127.,
     6  127.,127.,126.,126.,126.,125.,47*0.,124.,101.,81.,149.,124.,
     7      123.,124.,150.,2*124.,126.,103.,80.,152.,127.,0.,122.,
     8  102.,80.,151.,125.,124.,3*125.,151.,6*0.,124.,125.,101.,82.,
     9  151.,124.,151.,122.,3*123.,2*152.,6*0.,122.,127.,0.,4*80.,2*
     *      128./
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      DATA XWO6/.0301,.03044,.0293,.0291,.0320,.0293,.0302,.0236,.02,
     *          .0349,.0286,.0284,.0288,.0288,.0170,.0[illegible],.0129,.0108,
     *          .0191,.0162,.0164,.0162,.0194,.0252,.0258,.0201,.0164,
     3          .0296,.0[illegible]4,.[illegible]61,.0269,.0271,.03[illegible]4,.0390,.0308,.0249,
     4          .0472,.[illegible]78,.0399,.0411,.0411,.0445,.0357,.0297,.0546,
     5          .0456,.0464,.0468,.0561,.0459,.0520,.0446,.0354,.0294,
     6          .0546,.0366,.0454,.0453,0.,.0455,.0458,.0547,.045,.0444,
     7          .0445,.0307,.0299,.01[illegible].0153,.0153,.0153,.0154,.0155,
     8     .0156,47*0.,.0458,.0383,.03[illegible]5,2*.047,.0471,.0562,.0468,
     *        .0471,.0387,.0321,.025[illegible],.0391,0.,.0356,.0302,.0241,
     *       .0445,.0366,.0367,.0366,[illegible] 037,.0446,6*0.,.0454,.0471,
     A          .0378,.0299,.0564,[illegible],.0476,.0475,.0484,.0477,
     B        .0567,.0562,6*0.,.047,[illegible],.032,.0318,2*.0313,2*.0485/
      DATA XL[illegible]6/.0178,.0205,.0174,.01[illegible]2,.0182,.0186,.0146,.0118,
     *          .0213,.017,.0167,.017,.[illegible]4,.0106,.01,.0081,.0066,.0116,
     *          .0099,.0098,.0097,.0115,.017,.0155,.0126,.0104,.0183,
     3          .0182,.0153,.0154,.0153,.0186,.0271,.0214,.0171,.0319,
     4          .0267,.0278,.0273,.0293,.0269,.0218,.0177,.0316,.0268,
     5          2*.027,.0327,.0284,.0327,.0276,.0225,.0179,.031,.0218,
     6          .02 2,.0266,0.,.027,.0284,.0316,.0257,2*.0259,2*.0169,
     7       .0107,2*.0095,.0093,2*.0094,.0095,47*0.,.0273,.0223,.0182,
     8          .0329,.0274,.0277,.0274,.0325,.0271,.0272,.0269,.0219,
     9        .0177,.0316,.0264,0.,.0209,.0172,.0[illegible]3,.0258,.0212,.0213,
     *        .0214,.0211,.0212,.0258,6*0.,.0274,.027,.022,.0174,.0327,
     A     .0272,.0325,.0276,.0273,.0276,.027[illegible],2*.0327,6*0.,.0274,.0279,
     B          0.,.018,.0182,.0184,.0183,.0[illegible]75,.0275/
      DATA XTU6/83.,83.,72.,76.,78.,80.,78.,81.,84.,77.,81.,84.,90.,76.,
     *          80.,2*84.,85.,82.,85.,90.,120.,138.,66.,70.,80.,81.,86.,
     2          86.,83.,87.,127.,136.,70.,74.,77.,76.,81.,82.,120.,126.,
     3          74.,76.,2*80.,72.,74.,123.,128.,2*85.,80.,82.,83.,2*82.,
     4          81.,74.,0.,76.,126.,129.,76.,77.,78.,82.,4*83.,84.,3 85.
     5     ,47*0.,76.,77.,78.,78.,83.,80.,125.,127.,89.,78.,2*79.,78.,2*
     6     75.,0.,5*77.,2*88.,89.,117.,124.,6*0.,3*85.,2*84.,6.,84.,87.
     7          ,88.,87.,124.,127.,125.,6*0.,2*89.,0.,90.,2*89.,3*88./
      DATA XTF6/83.,83.,77.,76.,76.,80.,80.,82.,84.,80.,160.,251.,111.,
     *          77.,81.,84.,86.,89.,84.,162.,224.,241.,292.,71.,77.,89.,
     2          80.,81.,84.,179.,234.,227.,291.,76.,77.,78.,76.,207.,
     3          240.,248.,312.,80.,81.,82.,78.,191.,252.,263.,311.,95.,
     4          170.,82.,84.,86.,85.,87.,83.,189.,0.,225.,240.,296.,94.,
     5   92.,89.,91.,89.,88.,2*89.,94.,96.,97.,99.,47*0.,75.,76.,2*77.,
     6        189.,232.,242.,275.,185.,95.,84.,83.,81.,80.,79.,0.,5*
     7    77.,177.,214.,223.,225.,279.,6*0.,85.,3*86.,85.,173.,94.,240.
     8         ,229.,228.,231.,280.,276.,6*0.,2*90.,0.,90.,89.,90.,3*89./
      DATA IFUEL6/181*3/
      DATA SPACE6/14*5.,9*1.,26*5.,2*9.,16*5.,7*1.,47*0.,10*9.,5*10.,0.,
     1          10*8.,5*0.,13*7.,6*0.,2*9.,0.,6*9./
      DATA XMM6 /1.69,1.68,1.69,1.67,1.6,1.61,1.63,1.62,1.69,1.64,1.68,
     *          1.7,1.82,1.66,1.5,1.63,1.58,1.63,1.65,1.63,1.67,1.67,
     2          1.68,1.48,1.67,1.59,1.57,1.62,1.67,1.7,1.75,1.78,1.69,
     3          2*1.44,1.46,1.48,1.49,1.43,1.5,1.4,1.66,1.63,1.68,1.73,
     4          1.7,1.72,1.73,1.72,1.62,1.59,1.61,1.57,1.64,1.76,1.68,
     5          1.73,1.71,0.,1.66,2*1.73,1.75,1.71,1.72,1.82,1.76,1.48,
     6  2*1.61,3*1.64,1.65,47*0.,1.68,1.72,1.73,2*1.72,1.7,1.72,3*1.73
     7          ,1.44,1.47,1.46,1.5,1.48,0.,1.7,1.75,1.69,1.73,2*1.72,
     8       1.71,1.73,1.74,1.73,6*0.,1.66,1.74,3*1.72,1.73,1.74,1.72,
     9      1.74,1.75,2*1.73,1.72,6*0.,1.71,1.74,0.,1.78,1.74,1.7,1.71,
     *          1.78,1.76/
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      DATA IMP6/14*0,9*0,10*1,8*1,8*1,2*0,16*1,7*0,47*0,10*0,5*0,11*1,
     *         6*0,13*1,6*0,9*0/
      DATA XDU6/14*.027,9*.024,10*.027,8*.025,0*.027,2*.047,16*.027,
     1         7*.024,47*0.,10*.047,5*.042,11*.027,6*0.,13*.030,6*0.,
     2         9*.047/
      DATA XDF6/14*.025,9*.020,10*.025 9*.025,8*.025,2*.042,16*.025,
     1         7*.021,47*0.,10*.042,  .042,11*.025,6*0.,13*.028,6*0.,
     2         9*.042
C
C
      GO TO (101,102,103,104,105,106     IVEST
C                                IF INVES    ZUMG    IF INVEST = 2  NURICK
C                                IF INVEST 3 = HOUSEMAN
C                                IF INVEST = 4 = LAWVER
C                                IF INVEST= 5 = ROCKETDYNE
C                                IF INVEST= 6 .        R(OMS)
  101 DO   = XDO1(I)
      DF   = XDO1(I)
      PC   = XPC1(I)
      VO   = XVO1(I)
      VF   = XVF1(I)
      TO   = XTO1(I)
      TF   = XTF1(I)
      MR   = XMR1(I)
      MOM  = XMOM1(I)
      ICOM=ICUM1(I)
      IFUEL=IFUEL1(I)
      IMP=IMP1(I)
        WF = XWF1(I)
      SPLD=SPACE1(I)
      IF (IFUEL.EQ.1) SGFUEL=WINTP(TF,1,8,TN2H4,SGN2H4)
      IF (IFUEL.EQ.2) SGFUEL=WINTP(TF,1,8,TA50,SGA50)
      IF (IFUEL.EQ.3) SGFUEL=WINTP(TF,1,8,TMMH,SGMMH)
      SGN2O4 = 1.53-(12.5E-4*TO) + (11.7E-6*100.)
      GO TO 150
C
  102 DO   = XDO2(I)
      DF   = XDF2(I)
      PC   = XPC2(I)
      VO   = XVO2(I)
      VF   = XVF2(I)
      TO   = XTO2(I)
      TF   = XTF2(I)
      MR   = XMR2(I)
      MOM  = XMOM2(I)
      ICOM= ICOM2(I)
      IFUEL=IFUEL2(I)
      IMP=IMP2(I)
      SGN2O4 = 1.53-(12.5E-4*TO) + (11.7E-6*100.)
      IF (IFUEL.EQ.1) SGFUEL=WINTP(TF,1,8,TN2H4,SGN2H4)
      IF (IFUEL.EQ.2) SGFUEL=WINTP(TF,1,8,TA50,SGA50)
      IF (IFUEL.EQ.3) SGFUEL=WINTP(TF,1,8,TMMH,SGMMH)
      GO TO 150
  103 DO   = XDO3(I)
      DF   = XDO3(I)
      PC   = XPC3(I)
      VO   = XVO3(I)
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      TO = XTO3(I)
      TF = XTO3(I)
      MR = XRR3(I)
      MOM = XMOM3(I)
      ICOM=ICUM3(I)
      IFUEL=IFUEL3(I)
      IMP=IMP3(I)
      SGN2O4 = 1,53-(1?  E-4*TO) + (11,7E-6*100,)                     5
      IF (IFUEL,EQ,1) [illegible]EL=WINTP(TF,1,8,TH2H4,SGN2H4)          5
      IF (IFUEL,EQ,2) SG UEL=WINTP(TF,1,8,TA50,SGA50)                  5
      IF (IFUEL,EQ,3) SGFUEL=WINTP(TF,1,8,TMMH,SGMMH)                  5
      WO = (SGN2O4*(DO**2*0,785)*VO)/144,                              5
      WF = WO / MR                                                     5
      VF = (WF/SGFUEL/(DF**2*0,785))*144,                              5
      GO TO 150
  104 DO=XDO4(I)
      DF=XDF4(I)
      PC=XPC4(I)
      TO=XTO4(I)
      TF=XTF4(I)
      IFUEL = IFUEL4(I)
      SGN2O4=1,53-(12,5E-4*XTO4(I))+(11,7E-6*100,)
      IF (IFUEL,EQ,2) SGFUEL=WINTP(TF,1,8,TA50,SGA50)
      IF (IFUEL,EQ,3) SGFUEL=WINTP(TF,1,8,TMMH,SGMMH)
      VO=(XWO4(I)/((62,4*SGN2O4)*((3,1416*XDO4(I)**2)/4)))*144,
      VF=(XWF4(I)/((62,4*SGFUEL)*((3,1416*XDF4(I)**2)/4)))*144,
      MR=XMR4(I)
      MOM= ((62,4*SGFUEL)*VF**2) / ((62,4*SGN2O4)*VO**2)
      ICOM=ICUM4(I)
      TIMP=TIMP4(I)
      IFUEL=IFUEL4(I)
      IMP=IMP4(I)
      SPLD=SPACE4(I)
      XAT = XAT4(I)                                                    *NEW
      GO TO 150
  105 DO = XDO5(I)
      DF = XDF5(I)
      PC = XPC5(I)
      TO = XTO5(I)
      TF = XTF5(I)
      IFUEL = IFUEL5(I)
      VF = XVF5(I)
      SGFUEL = WINTP(TF,1,8,TMMH,SGMMH)
      SGN2O4 = 1,53-(12,5E-4*XTO5(I))+(11,7E-6*100,)
      WF =(SGFUEL*(DF**2*0,788)*VF)/144,
      MR = XMR5(I)
      WO = MR * WF
      VO =(WO / SGN2O4 /(DO**2*0,785)) * 144,
      ICOM = ICOM5(I)
      IMP = IMP5(I)
      SPLD = SPACE5(I)
      GO TO 150                                                        6
  106 DO = XDO6(I)                                                     6
      DF = XDF6(")                                                     6
      PC = XPC6(.)                                                     6
      TO = XTO6/ "                                                     6
      TF = XTF6 I,                                                     6
```

```
      WO = XWO6(I)
      WF = XWF6(I)
      IFUEL = IFUEL6(I)
      SGN2O4 = 1.53 -(12.5E-4* TO)+(11.7E-6*100.)
      SGFUEL = WINTP(TF,1,8,TMMM,SGMMM)
      VO =(XWO6(I)/((62.4*SGN2O4)*((3.1416*DO**2)/4)))*144.
      VF =(XWF6(I)/((62.4*SGFUEL)*((3.1416*DF**2)/4)))*144.
      MR = XMR6(I)
      MOM =((62.4*SGFUEL)*VF**2) / ((62.4*SGN2O4)*VO**2)
      ICON = ICON6(I)
      IFUEL = IFUEL6(I)
      IMP = IMP6(I)
      SPLD = SPACE6(I)
  150 CONTINUE
      RETURN
      END
```

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```
      DIMENSION TITLE(20),ITEST(200),INV(600),XLDI(20),
     *TFA50(12),VAPA50(12),TFN2H4(13),VAPN2H(13),TFMMH(11),VAPMMH(11),
     *TON2O4(13),VAPN2O(13),IINJT(20),
     1   IFUELN(3),ICOMN(6),INVN(6),INJECT(48),POUT2(41,19),IPOUT2(41,3)
     2    ,X(300,3,6),Y(300,3,6),IHSP(4,6),DFP(4)
     3   ,TOVISO(6),VISO(6),TOST(9),SURTEN(9)
     4   ,DOT(20),DOVIS(20),EOT(12),EOVIS(12),FOT(15),FOSTF(18)
     5,AT(20)
C
       REAL IMP,MOM,MR
       COMMON/DATAI/DO,DF,PC,VO,VF,TO,TF,MR,MOM,ICOM,IFUEL,IMP,RMF,SPLD
      1,MF,TIMP,MO,XAT
       NAMELIST/DUMP/SGN2O4,SGFUEL,VISF,VISO1
       COMMON/BLK2/TN2H4(8),SGN2H4(8),TA50(8),SGA50(8),TN2O4(10),
      1SN2O4(10) ,TMMH(8),SGMMH(8) ,SGFUEL,SGN2O4
       DATA INVN/' ZUNG','NURICK','HOUSEM','LAWVER','RCKTD','UMS-75',/
       DATA ICOMN/'  MIX ','  SEP ','  POP ',' UNDEF','  M/S ','  M/P ',/
       DATA IFUELN/'N2H4','A-50','MMH',/
       DATA INJECT/' UNLI','KE-DO','UBLET','      ',' XDTI','      ',
      *'  SPL','ASH P','LATE ','      ','TR.PL','ET    ',' SMAL','L TRI',
      *'PLET','   V ','- DOU','BLET ','      ','XDT-A','      ',
      *'   VD','T - 3','60    ',' LOL ','CORE ','LO DP',' L-U-','L  BA',
      *'RRIER',' L-U-','L  CO','RE    ',' VDT-','A  CO','RE    ',' LAM ',
      *'L-U-L',' CORE',' VDT-','A  BA','RRIER','T-LOL',' COR ','HI DP',
      *' T- L','OL-B ',' CORE',/
       DATA TFA50/50.,80.,100.,120 ,140.,160.,180.,200.,240.,280.,300.,
      *          340.,/
       DATA VAPA50/.95,2.3,3.8,6.0,8.75,13.,19.,26.,48.,80.,105.,165./
       DATA TFN2H4/40.,60.,80.,100.,120.,140.,160.,180.,200.,220.,260.,
      *           300.,340.,/
       DATA VAPN2H/.075,.17,.32,.65,1.15,1.9,3.2,4.8,7.3,11.,23.,43.,77.,/
       DATA TFMMH /40.,65.,90.,115.,140.,165.,190.,215.,240  290.,340.,/
       DATA VAPMMH/.29,.67,1.42,2.8,5.15,9.,15.2,25.,35.5,73.5,135.,/
       DATA TON2O4/32.,50.,70.,80.,90.,100.,110.,120.,130.,140.,150.,
      *          160.,170./
       DATA VAPN2O/5.08,8.56,14.78,18.98,24.21,30.69,38.62,48.24,59.98,
      *          74.12,91.06,111.24,135.14/
C
       NAMELIST / INPUT/ITEST,NSETS,INV,IPLOT,DFP,NPLOT,IPRINT,IPLT,XLDI
      1          ,INFUEL,IINJT,XXDF,AT,IBILL,NIINJT,NFP
C
       READ(5,1000) TITLE
C
       READ(5,INPUT)
C                  HERE WE SET THE CASES TO BE PROCESSED
C                       NSETS  =  NO. OF GROUPS OF SEQUENCEIAL TESTS
C                       ITEST  =  RANGE OF TESTS IN SEQUENCE ITEST(I)-ITEST(N)
C                       INV    =  INVESTIGATORS  FLAG  1 ZUNG, 2 NURICK
C                       IINJT  =  INJECTOR TYPE OF EACH GROUP OF TESTS
C                       AT     =  THROAT AREA FOR EACH SET OR GROUP
C                       IBILL  =  WHICH PAGE OF OUTPUT; 0= MRVP, 1= C*
C                       NIINJT =  INJECTOR TO BE PLOTTED
C                       NFP    =  FUEL TO BE PLOTTED
C
C
       WRITE (6,INPUT)
       IPAGE=0
```

```
      K=0
      J=1
C     SYMBOL COUNTERS ZEROED  FOR ZETA PLOTTER BELOW
      IMSP(1,1) =0
      IMSP(2,1) =0
      IMSP(3,1) =0
      IMSP(4,1) = 0
      IMSP(1,2) =0
      IMSP(2,2) =0
      IMSP(3,2) =0
      IMSP(4,2) = 0
      IMSP(1,3) =0
      IMSP(2,3) =0
      IMSP(3,3) =0
      IMSP(4,3) = 0
      IMSP(1,4) =0
      IMSP(2,4) =0
      IMSP(3,4) =0
      IMSP(4,4) = 0
      IMSP(1,5)=0
      IMSP(2,5)=0
      IMSP(3,5)=0
      IMSP(4,5)=0
      IMSP(1,6)=0
      IMSP(2,6)=0
      IMSP(3,6)=C
      IMSP(4,6)=0
      DO 1 II=1,NSETS
      INJT = IINJT(II)
      NTEST=ITEST(J+1)-ITEST(J)+1
      IPROC=NTEST+ITEST(J)-1
      INDEX=ITEST(J)
      J=J+2
C
C                 HERE WE START PROCESSING EACH TEST OF NSETS
C
      DO 2 I=INDEX,IPROC
C                          CHECK FOR INVESTIGATORS
      IPAGE=IPAGE+1
      IPAGE2 = IPAGE2 + 1
      K=K+1
      INVEST=INV(K)
C     HERE WE GO TO THE SUBROUTINES
      CALL DATA(INVEST,I)
      XLD = SPLD
      IF(SPLD.LT. 0.01) XLD = XLDI(II)
      IF(SPLD.LT. 0.01) SPLD = XLDI(II)
      IF(VO .LE. 0. ) IPAGE=IPAGE-1
      IF(VO.LE.0.) IPAGE2 = IPAGE2 - 1
      IF(VO .LE. 0. ) GO TO 2
C ****************************************************
      XLDIMP=SPLD/2./(SIN(0.5*IMP/57.))
      XLI = DF + XLDIMP
      DIV = XLI/12./VF
      FNF=WF*VF*SIN(IMP/2./57.3)/32.174
      A = 3.14159*DF**2/4./SIN(IMP/2./57.3)
      DPF=FNF/A
```

```
C ****************************************************
      DATA DOT/40.,80.,100.,135.,160.,200.,222.,263.,303.,360.,400.,
     *450.,500.,550.,600.,620.,650.,685.,700.,715./
      DATA DOVIS/82.E-5,60.E-5,50.E-5,40.E-5,34.E-5,27.5E-5,22.3E-5,
     *20.E-5,17.2E-5,14.E-5,12.E-5,10.E-5,8.4E-5,7.E-5,5.4E-5,4.4E-5,
     *4.E-5,3.E-5,2.45E-5,1.8E-5/
      DATA EOT/20.,45.,60.,80.,100.,128.,150.,180.,200.,240.,260.,300./
      DATA EOVIS/100.E-5,82.E-5,70.E-5,60.E-5,50.E-5,40.E-5,34.E-5,
     *30.E-5,27.E-5,22.E-5,20.E-5,17.E-5/
      DATA FOT/70.,100.,113.,120.,133.,140.,152.,160.,170.,180.,187.,
     *200.,220.,235.,250.,260.,280.,295./
      DATA FOSTF/1.69E-4,1.64E-4,1.6E-4,1.58E-4,1.55E-4,1.53E-4,1.5E-4,
     *1.48E-4,1.45E-4,1.42E-4,1.40E-4,1.36E-4,1.3E-4,1.25E-4,1.2E-4,
     *1.17E-4,1.1E-4,1.05E-4/
      DATA TOVISO / 50.,100.,150.,200.,250.,300./
      DATA VISO / 31.5E-5,22.5E-5,16.3E-5,10.9E-5,6.0E-5,2.5E-5/
      DATA TOST / 20.,40.,90.,140.,165.,190.,215.,240.,290./
      DATA SURTEN / 2.235E-3,2.05E-3,1.61E-3,1.18E-3,.978E-3,.78E-3,.595
     *E-3,.42E-3,.119E-3/
      IF (IFUEL.NE.1) GO TO 151
      RHF=62.4*WINTP(TF,1,8,TN2H4,SGN2H4)
C
C     STF=(LBF/FT)
C     VISF=(LBM/FT-SEC)
C
      STF=5.261E-3-9.25E-6*TF
      VISF=WINTP(TF,1,20,DOT,DOVIS)
      GO TO 153
  151 IF (IFUEL.NE.2) GO TO 152
      RHF=62.4*WINTP(TF,1,8,TA50,SGA50)
      STF=WINTP(TF,1,18,FOT,FOSTF)*12
      VISF=WINTP(TF,1,12,EOT,EOVIS)
      GO TO 153
  152 IF (IFUEL.NE.3) GO TO 153
      RHF=62.4*WINTP(TF,1,8,TMMH,SGMMH)
      STF = 4.3450E-3 - 3.785E-6 * (TF+460.)
      VISF=10**(-11.167+(11023.1/(TF+460.))-(5.6565E+6/((TF+460.)**2.))+
     1(1.0794E+9/((TF+460.)**3.)))
C     *************************************************************
  153 RHOG=(PC*144.)/(77.*5000.)
      IF (TIMP.LT..0001) GO TO 87
      DELTI=TIMP-TF
   87 CONTINUE
      WEF = (RHOG * VF**2 * DF )/(386.4*STF)
      REF =(SGFUEL*62.4*VF*DF)/(VISF*12.)
      STO = WINTP(TO,1,9,TOST,SURTEN)
      VISO1 = WINTP (TO,1,6,TOVISO,VISO)
      WEO = (RHOG * VO**2 * DO )/(386.4*STO)
      REO=(SGN2O4 * 62.4 *VO *DO)/(VISO1* 12.)
      WEOC=12.*(1+((VISO1**2.)/(RHOG*DO*STO*2.68))**.36)
      WEFC=12.*(1+((VISF**2.)/(RHOG*DF*STF*2.68))**.36)
      WEOR= WEO/WEOC
      WEFR=WEF/WEFC
      VAVG = (1./(MR+1.))*(VO*MR+VF)
      RELF =REF*XLD
      RELO = REO*XLD
      IF(IFUEL.EQ.1) PPF = WINTP(TF,1,13,TFN2H4,VAPN2H)
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      IF(IFUEL.EQ.2) PPF = WINTP(TF,1,12,TFA50,VAPA50)
      IF(IFUEL.EQ.3) PPF = WINTP(TF,1,11,TFMMH,VAPMMH)
      PPO = WINTP(TO,1,13,TON2O4,VAPN2O)
      IF(IFUEL.EQ.1)  XMWF = 32.0
      IF(IFUEL.EQ.2)  XMWF = 42.0
      IF(IFUEL.EQ.3) XMWF = 46.0
      XMRVP = PPO*92.0*(TF+460.) /PPF/XMWF/(TO+460.)
      XF = PPF /PC
      XO  = PPO/PC
      REGF = (.000373*PC*VF*DF)/(.000053*12.)
      SSP = WEF/(REGF**0.5)
      WT = WO + WF
      CSTAR = PC *XAT * 32.14 / WT
      XP = (XF*XO)**.5
C     RESIDENCE TIME IS DF/VF AND,WILL BE CALLED RESID
      RESID = DF/VF/12.
      REACT=REF*XP
C     THE DIMENSION OF REACT IS IN SECONDS
C      ************************************************************
      IPOUT2(IPAGE2,1) = IFUELN(IFUEL)
      IPOUT2(IPAGE2,3) = ICOMN(ICOM)
       POUT2(IPAGE2,4) = PC
       POUT2(IPAGE2,5) = VAVG
       POUT2(IPAGE2,6) = WEF
       POUT2(IPAGE2,7) = WEO
       POUT2(IPAGE2,8) = REF
       POUT2(IPAGE2,9) = REO
       POUT2(IPAGE2,10)= DELTI
       POUT2(IPAGE2,11)= RELF
       POUT2(IPAGE2,12)= RELO
       POUT2(IPAGE2,13)= PPF
       POUT2(IPAGE2,14)= PPO
       POUT2(IPAGE2,15)= XMRVP
       POUT2(IPAGE2,16)= XF
       POUT2(IPAGE2,17)= XO
      POUT2(IPAGE2,18)=XP
      POUT2(IPAGE2,19)=RESID
      IF(PC   .LE. 0.)WRITE(6,88) PC,ITEST
      IF(DIV  .LE. 0.)WRITE(6,89) DIV,ITEST
      IF(PC   .LE. 0.) GO TO 40
C     I DELETED, IF(DIV.LE.0) GO TO 40
   88 FORMAT(5X,' PC= ',F6.1,'    ITEST = ',I4,)
   89 FORMAT(5X,'DIV= ',E10.5,'    ITEST = ',I4,)
C     THE FOLLOWING STATEMENT DETERMINES INJECTOR TO BE PLOTTED
      IF(INJT.NE.NIINJT) GO TO 10
      IF(IFUEL.EQ.1)  N = 1
C                            FUEL USED IS N2H4
      IF(IFUEL.EQ.2)  N = 2
C                            FUEL USED IS A-50
      IF(IFUEL.EQ.3)  N = 3
C                            FUEL USED IS MMH
C     DELETED, IF(INJT.GT.1) GO TO 40
      IIFUEL = IFUEL
      IF(IPLOT .EQ. 0) GO TO 40
      IF(ICOM.EQ.5) IICOM = 4
      IF(ICOM.EQ.6) IICOM = 1
      IF(ICOM.LT. 5)IICOM = ICOM
```

```
      IF(ICOM.EQ.4) GO TO 10
C     DELETED.  IF((PPC-PPF).GE.PC) GO TO 10                                 9
      IF(DF.GT.XXDF.OR.DF.LT.XXDF) GO TO 10                                  9
      ZPDF = DF                                                              9
      L = IM3P(IICOM,N) + 1
      X(L,IICOM,N) = ALOG10(REACT)                                           9
      Y(L,IICOM,N) = ALOG10(PC)                                              9
      IMSP(IICOM,N) = L
   10 CONTINUE
C
   40 CONTINUE
C
C
      IF(INVEST .EQ. 3) NN='AN'
      IF(INVEST .NE. 3) NN=' '
      DV = DF/12./VF
      IF(I.GT.307.AND.I.LT.310) ICOM=3
      IF(I.GT.475.AND.I.LT.479) ICOM=1
      IF(IPAGE .GT. 40) IPAGE=1
      IF( K .GT. 1 .AND.(INV(K)-IPRNT) .NE. 0) IPAGE=1
      IF ( K .EQ. 1 .AND. IPAGE .EQ. 1 ) WRITE(6,5000)
      INO= I
      IF ( INVEST .EQ. 4 )  INO= INO + 100
      IF(INVEST.EQ.6) INO = INO + 100
      IPOUT2(IPAGE2,2) = INO
      IF(IPAGE .EQ. 1) WRITE(6,3000) TITLE
      IF(IPAGE .EQ. 1) WRITE(6,4001) INVN(INVEST),NN
      WRITE(6,3001) IFUELN(IFUEL),INO,INJECT(INJT),INJECT(INJT+1),
     *    INJECT(INJT+2),                           DO,DF,XLD,IMP,PC,VO,
     1VF,TO,TF,MR,MOM,ICOMN(ICOM),REACT                                      9
      IPRNT=INVEST
      IF(IPAGE.NE.40) GO TO 2
      WRITE(6,5002)
      WRITE(6,3000) TITLE
      WRITE(6,4002) INVN(INVEST),NN                                          9
      DO 999 III=1,40                                                        9
      WRITE(6,3002) (IPOUT2(III,NNN),NNN=1,3),(POUT2(III,NNN),NNN=4,19)      9
  999 CONTINUE
      IPAGE2 = 0
    2 CONTINUE
    1 CONTINUE
      IF(IPAGE.EQ.40) GO TO 9998
      WRITE(6,5002)
      WRITE(6,3000) TITLE
      WRITE(6,4002) INVN(INVEST),NN                                          9
      DO 9999 III=1,IPAGE                                                    9
      WRITE(6,3002) (IPOUT2(III,NNN),NNN=1,3),(POUT2(III,NNN),NNN=4,19)      9
 9999 CONTINUE
 9998 CONTINUE
        IF(IPLOT .EQ. 0) GO TO 60
      CALL PLOTS(0,0,7)
      CALL PLOT(-1.0,1.0,-3)                                                 9
      CALL LOG(0.,0.,8.,1,4,48HFUEL REYNOLDS NUMBER X SQRT NORM PART PRE   *NEW
     1SS PROD,48,0)                                                       *NEW
      XM = 1.                                                             *NEW
      DX = 4./8.                                                          *NEW
      CALL LOG(0.,0.,9.,1,2,24HCHAMBER PRESSURE  (PSIA),24,1)             ***4
```

```
      IF(INVEST.EQ.1) CALL SYMBOL(3.5,9.,.1,18HINVESTIGATOR  ZUNG,0.,18)        *NEW
      IF(INVEST.EQ.2) CALL SYMBOL(3.5,9.,.1,20HINVESTIGATOR  NURICK,0.,         *NEW
     *20)                                                                       ***2
      IF(INVEST.EQ.3) CALL SYMBOL(3.5,9.,.1,22HINVESTIGATOR  HOUSEMAN,0.        *NEW
     *,22)                                                                      ***1
      IF(INVEST.EQ.4) CALL SYMBOL(3.5,9.,.1,20HINVESTIGATOR  LAWYER,0.,         *NEW
     *20)                                                                       ***1
      IF(INVEST.EQ.5) CALL SYMBOL(3.5,9.,.1,24HINVESTIGATOR  ROCKETDYNE,        *NEW
     *0.,24)                                                                    ***1
      IF(INVEST.EQ.6) CALL SYMBOL(3.5,9.,.1,20HINVESTIGATOR  OMS-75,0.,         *NEW
     *20)                                                                       ***1
      CALL SYMBOL(3.5,8.5,.1,11HINJECTOR = ,0.,11)                              *NEW
      CALL SYMBOL(999.,999.,.1,INJECT(NIINJT),0.,5)                             ***1
      CALL SYMBOL(999.,999.,.1,INJECT(NIINJT+1),0.,5)                              9
      CALL SYMBOL(999.,999.,.1,INJECT(NIINJT+2),0.,5)                              9
      CALL SYMBOL(3.5,8.,.1,5HDF = ,0.,5)                                       *NEW
      CALL NUMBER(999.,999.,.1,ZPOF,0.,3)                                       ***1
      CALL SYMBOL(3.5,7.5,.1,7HFUEL = ,0.,7)                                    *NEW
      IF(NPLOT.EQ.NFP) CALL SYMBOL(4.5,7.5,.1,IFUELN(NFP),0.,4)                 *NEW
      IF(NPLOT.EQ.1.AND.NFP.EQ.2) CALL SYMBOL(9.5,7.5,.1,13HN2H4 AND A-5        ***2
     *0,0.,13)                                                                     9
      IF(NPLOT.EQ.1.AND.NFP.EQ.3) CALL SYMBOL(9.5,7.5,.1,12HN2H4 AND MMH           9
     *,0.,12)                                                                      9
      IF(NPLOT.EQ.2.AND.NFP.EQ.3) CALL SYMBOL(9.5,7.5,.1,12HA-50 AND MMH           9
     *,0.,12)                                                                      9
      IF(NPLOT.EQ.1.AND.NFP.EQ.3) CALL SYMBOL(9.5,7.5,.1,19HMMH, A-50, A           9
     *ND N2H4,0.,19)                                                               9
      DO 601 K= NPLOT,NFP                                                          7
C     THE ABOVE WAS,  K = NPLOT,3                                                  8
C                         IF NPLOT = 3  (ONLY MMH FUEL PLOTTED)
C                         IF NPLOT = 2  (BOTH MMH & A-50 FUELS PLOTTED)
C                         IF NPLOT = 1  (MMH, A-50, & N2H4 FUELS PLOTTED)
      DO 601 I=1,4                                                                 9
C                                             I = ICOM = 1 (MIX)
C                                             I = ICOM = 2 (SEP)
C                                             I = ICOM = 3 (POP)
C                                              I = ICOM = 4 (M/S)                  9
      IF(K.EQ.1 .AND. I.EQ.1)  ISYMB = 10
      IF(K.EQ.1 .AND. I.EQ.2)  ISYMB = 11
      IF(K.EQ.1 .AND. I.EQ.3)  ISYMB = 6
      IF(K.EQ.1 .AND. I.EQ.4)  ISYMB = 12                                          9
      IF(K.EQ.2 .AND. I.EQ.1)  ISYMB = 1
      IF(K.EQ.2 .AND. I.EQ.2)  ISYMB = 4
      IF(K.EQ.2 .AND. I.EQ.3)  ISYMB = 7
      IF(K.EQ.2 .AND. I.EQ.4)  ISYMB = 5                                           9
      IF(K.EQ.3 .AND. I.EQ.1)  ISYMB = 0
      IF(K.EQ.3 .AND. I.EQ.2)  ISYMB = 3
      IF(K.EQ.3 .AND. I.EQ.3)  ISYMB = 2
      IF(K.EQ.3 .AND. I.EQ.4)  ISYMB = 9                                           9
      IF (IMSP(I,K).EQ.0 ) GO TO 601
      CALL PDATA(X(1,I,K),Y(1,I,K),IMSP(I,K),1,-1,ISYMB,XM,DX,1.,2./9.,            9
     *.05)                                                                         9
C
  601 CONTINUE
      CALL PLOT(8.5,0.,-3)
  600 CONTINUE
      CALL PLOT(8.5,-1.5,999)
```

```
   60 CONTINUE
   50 CONTINUE
 1000 FORMAT(20A4)
 3000 FORMAT(//40X,20A4,/)
 5000 FORMAT(1H1,T120,'PAGE 1 OF 2')
 5002 FORMAT(1H1,T120,'PAGE 2 OF 2')
 4001 FORMAT(//T40,'HYPERGOLIC  STREAM  IMPINGMENT  DATA  COMPILATION',
     1///T54,'INVESTIGATOR   ',A6,A2,
     2    ///T44,'IMP',/T2,'FUEL TEST    INJECTOR     DO   OF   L/O  ANG
     3LE   PC     VO     VF     TO     TF     MR  MF/MO  MODE     REACT',
     */T2,
     4'TYPE  NO.       TYPE       (IN) (IN)        (DEG) (PSIA) (FT/S) (FT/
     5S)  (F)  (F)                         (SEC)',/)
 3001 FORMAT(I2,A6,I3,3A5,2F5.3,F5.0,F6.0,F7.0,2F7.1,2F6.0,F6.2,F6.3,A7,
     *E8.3)
 4002 FORMAT(I2,A6,I3,A6,2F6.0,2F6.1,2E8.3,F6.0,E9.2,E8.2,3F6.1,2F5.2,
     *E8.2,E8.2)
 4002 FORMAT(//T40,'HYPERGOLIC  STREAM  IMPINGMENT  DATA  COMPILATION',
     1///T54,'INVESTIGATOR   ',A6,A2,
     2///T2,'FUEL TEST  MODE   PC    VAVG  MEF     MEO   REF      REO    DE
     3LTI   RELF    RELO   PPF    PPO   MRVP  XF    XO      XP    RESID',/
     4T2,'TYPE  NO.         (PSIA)                                    (DEG F
     5)               (PSIA)(PSIA)'/)
      END
```

```
      FUNCTION WINTP(U,NU,NV,V1,V2)
      DIMENSION V1(1),V2(1)
      IF (NU-NV)2,13,13
    2 IF ((U-V1(NU))/(V1(NV)-V1(NU))) 3,13,4
C      SPECIAL FLAG TO WARN OF EXCEEDING LOWER TABLE RANGE
    3 IF(ABS(U-U1) .LE. .00001) GO TO 13
      U1=U
   13 WINTP=V2(NU)
      RETURN
    4 IF((U-V1(NV))/(V1(NV)-V1(NU))) 6,15,5
C      SPECIAL FLAG TO WARN OF EXCEEDING UPPER TABLE RANGE
    5 IF(ABS(U-U1) .LE. .00001) GO TO 15
      U1=U
   15 WINTP=V2(NV)
      RETURN
    6 N=NU+1
      DO 7 I=N,NV
      IF((U-V1(I))/(V1(NV)-V1(NU))) 8,8,7
    7 CONTINUE
      GO TO 9
    8 J=I-1
      WINTP = (U-V1(J))/(V1(I)-V1(J))
      WINTP = V2(J)+(V2(I)-V2(J))*WINTP
      RETURN
    9 CONTINUE
      STOP
      END
```

APPENDIX E

TASK III AND IV DATA SUMMARIES

List of Appendix E Symbols

Test Condition Log (Table E-I

Test Result Summary Impingement Data

Compilation (Table E-III)

List of Appendix E Data Sources

APPENDIX E

LIST OF SYMBOLS

D_f, D_o	Fuel and oxidizer orifice diameter, in.
DELTI	Impingement point temperature rise, °F
Imp. Angle	Propellant Stream Impingement angle, °
L/D	Orifice length to diameter ratio
MF/MO	Fuel to oxidizer momentum ratio
MR	Oxidizer to fuel mixture ratio
MRVP	Vapor phase mixture ratio
Pc	Chamber pressure, psia
PFJ,POJ	Fuel and oxidizer manifold pressure, psia
PFT,POT	Fuel and oxidizer tank pressure, psia
PPF, PPO	Fuel and oxidizer partial pressures, psia
ΔPFJ, ΔPOJ	Fuel and oxidizer injector pressure drop, psid
PN2	Nitrogen Gas Pressure, psia
NOZ	Chamber throat diameter, in.
REACT	Reactivity, $Re_f \times XP$
REF,REO	Fuel and oxidizer orifice Reynolds number based on dia.
RELF,RELO	Fuel and oxidizer orifice Reynolds no, based on length
RESID	Propellant stream contact time, sec.
TF (TFJ)	Fuel temperature,°F
TO (TOJ)	Oxidizer temperature, °F
VANG	Average of fuel and oxidizer injection velocity, ft/sec
VF, VO	Fuel and oxidizer injection velocity, ft/se

List of Symbols (cont.)

WEF, WEO	Fuel and oxidizer Weber no.
$\dot{W}_F$, $\dot{W}_O$	Fuel and oxidizer weight flow rate, lbm/sec
XF, XO	Fuel and oxidizer mole fraction
XP	Product of fuel and oxidizer mole fraction ** 1/2

C-2

HIGH PERFORMANCE N_2O_4/AMINE ELEMENTS

Table E-1 TEST CONDITION LOG

Test No.	D_f	Fuel	P_c	MR	T_F	T_o	ΔP_f	Noz	P_{N2} (PSIG)	P_{OT} (PSIG)	P_{FT} (PSIG)	DATE	f-Stop	FR/Rate (PPS)	Process	Light Meter W/2 N.D.F.	Remarks
OC-27-101	.020	MMH	300	1.6	Amb	Amb	100	0.330	1350	385	385	10/1/74	16	400	Normal	.6	Long Impingement Element
-102	.020	MMH	300	1.6	Amb	Amb	100	0.330	1350	380	390	10/1/74	11	400	Normal	18	Long Impingement Element
-103	.020	MMH	300	1.6	Amb	Amb	100	0.330	1350	385	385	10/1/74	22	400	Normal	18	Long Impingement Element
-104	.020	MMH	300	1.6	Amb	Amb	100	0.330	1350	385	385	10/1/74	3.3	8000	Normal	18	Long Impingement Element
-105	.020	MMH	500	1.6	Amb	Amb	100	0.265	1463	585	585	10/1/74	3.3	8000	1 Stop	18	Long Impingement Element
-106	.020	MMH	1000	1.6	Amb	Amb	100	0.187	1463	1085	1085	10/1/74	3.3	8000	Normal	18	Long Impingement Element Poloroid Filter Paper & Ground Glass Diffuser Installed Between Backlite & Window
-107	.020	MMH	300	1.6	Amb	Amb	100	0.330	1350	385	385	10/7/74	8	400	Normal	15	Long Impingement Element
-108	.020	MMH	250	1.6	Amb	Amb	100	0.330	1095	335	335	10/7/74	8	400	Normal	15	Long Impingement Element
-109	.020	MMH	200	1.6	Amb	Amb	100	0.432	1568	285	285	10/7/74	8	400	Normal	15	Long Impingement Element
-110	.020	MMH	150	1.6	Amb	Amb	100	0.432	1129	235	235	10/7/74	8	400	Normal	15	Long Impingement Element
-111	.020	MMH	100	1.6	Amb	Amb	100	0.563	1350	185	185	10/7/74	3.3	8000	Normal	15	Long Impingement Element
-112	.020	A-50	100	1.6	Amb	Amb	20	0.563	1533	105	105	10/8/74	3.3	8000	1 Stop	15	Long Impingement Element Moved camera to opposite Window & added front lighting
-113	.020	A-50	100	1.6	Amb	Amb	100	0.563	1350	185	185	10/12/74	5.6	400	Normal	14	Long Impingement Element

Test No.	D_f	Fuel	P_c	MR	T_F	T_o	ΔP_f	Noz	P_{N2} (PSIG)	P_{OT} (PSIG)	P_{FT} (PSIG)	DATE	f-Stop	FR/Rate (PPS)	Process	Light Meter W/2 N.D.F.	REMARKS
OC-27-114	.020	A-50	150	1.6	Amb	Amb	100	0.432	1129	235	235	10/12/74	5.6	400	Normal	14	Long Impingement Element
-115	.020	A-50	200	1.6	Amb	Amb	100	0.432	1568	285	285	10/12/74	5.6	400	Normal	14	Long Impingement Element
-116	.020	A-50	250	1.6	Amb	Amb	100	0.330	1095	335	335	10/12/74	5.6	400	Normal	14	Long Impingement Element
-117	.020	A-50	300	1.6	Amb	Amb	20	0.330	1646	305	305	10/12/74	5.6	400	Normal	14	Long Impingement Element
-118	.020	A-50	300	1.6	Amb	Amb	100	0.330	1350	335	385	10/12/74	5.6	400	Normal	14	Long Impingement Element
-119	.020	A-50	500	1.6	Amb	Amb	100	0.265	1463	585	585	10/12/74	5.6	400	Normal	14	Long Impingement Element
-120	.020	A-50	1000	1.6	Amb	Amb	100	0.187	1463	1085	1085	10/12/74	5.6	400	Normal	14	Long Impingement Element
-121	.020	A-50	150	1.6	Amb	Amb	100	0.432	1129	235	235	10/12/74	5.6	400	Normal	14	Rerun of #114 Reduced window purge from 10X to 1X
-122	.020	A-50	300	1.6	Amb	Amb	100	0.187	360	385	385	10/12/74	3.3	4000	Normal	14	Long Impingement Element
-123	.020	A-50	300	1.6	Amb	Amb	100	0.187	360	385	385	10/12/74	3.3	4000	Normal	14	Repeat of 122
-124	.020	MMH	1000	1.6	Amb	Amb	100	0.187	1463	1085	1085	10/16/74	5.6	400	Push 1 Stop	14	Increased purge flow to 10X Short Impingement Element
-125	.020	MMH	500	1.6	Amb	Amb	100	0.265	1463	585	585	10/16/74	5.6	400	Push 1 Stop	14	Short Impingement Element
-126	.020	MMH	300	1.6	Amb	Amb	100	0.330	1350	385	385	10/16/74	5.6	400	Push 1 Stop	14	Short Impingement Element
-127	.020	MMH	300	1.6	Amb	Amb	20	0.330	1646	305	305	10/16/74	5.6	400	Push 1 Stop	14	Short Impingement Element
-128	.020	MMH	250	1.6	Amb	Amb	100	0.330	1095	335	335	10/16/74	5.6	400	Push 1 Stop	14	Short Impingement Element
-129	.020	MMH	200	1.6	Amb	Amb	100	0.432	1568	285	285	10/16/74	5.6	400	Push 1 Stop	14	Short Impingement Element
-130	.020	MMH	150	1.6	Amb	Amb	100	0.432	1129	235	235	10/16/74	5.6	400	Push 1 Stop	14	Short Impingement Element

Test No.	D_f	Fuel	P_c	MR	T_F	T_o	ΔP_f	Noz	P_{N2} (PSIG)	P_{OT} (PSIG)	P_{FT} (PSIG)	DATE	f-Stop	FR/Rate (PPS)	Process	W/2 N.D.F.	REMARKS
OC-27-131	.020	MMH	100	1.6	Amb	Amb	100	0.563	1350	185	185	10/16/74	5.6	400	Push 1 Stop	14	Short Impingement Element
-132	.020	MMH	125	1.6	Amb	Amb	100	0.563	1732	210	210	10/16/74	3.3	4000	Push 1 Stop	14	Short Impingement Element
-133	.020	MMH	500	1.6	Amb	Amb	100	0.265	1463	585	585	10/17/74	Still Photo				Long Impingement Element
-134	.020	MMH	100	1.6	200	Amb	100	0.563	1350	185	185	10/23/74	5.6	400	Push 1 Stop	14	Long Impingement Element
-135	.020	MMH	125	1.6	200	Amb	100	0.563	1923	210	210	10/23/74	5.6	400	Push 1 Stop	14	Long Impingement Element
-136	.020	MMH	150	1.6	200	Amb	100	0.432	1129	235	235	10/23/74	5.6	400	Push 1 Stop	14	Long Impingement Element
-137	.020	MMH	200	1.6	200	Amb	100	0.432	1568	285	285	10/23/74	5.6	400	Push 1 Stop	14	Long Impingement Element
-138	.020	MMH	250	1.6	200	Amb	100	0.330	1095	335	335	10/23/74	5.6	400	Push 1 Stop	14	Long Impingement Element Heater Pump Seal Malf. installed T/C @ Imping. Pt.
-139	.020	MMH	100	1.6	Amb	Amb	20	0.563	2110	101	105	10/25/74	5.6	400	Push 1 Stop	14	Long Impingement Element
-140	.020	MMH	100	1.6	Amb	Amb	100	0.563	1350	181	185	10/25/74	5.6	400	Push 1 Stop	14	
-141	.020	MMH	100	1.6	Amb	Amb	100	0.563	1350	181	185	10/25/74	5.6	400	Push 1 Stop	14	Changed T/C from 0.01" Dia. to 0.02" Dia. prior to test 142
-142	.020	MMH	125	1.6	Amb	Amb	100	0.563	1923	206	210	10/25/74	5.6	400	Push 1 Stop	14	Long Impingement Element
-143	.020	MMH	125	1.6	Amb	Amb	20	0.432	1516	126	130	10/25/74	5.6	400	Push 1 Stop	14	Long Impingement Element
-144	.020	MMH	150	1.6	Amb	Amb	20	0.432	1839	151	155	10/25/74	5.6	400	Push 1 Stop	14	Long Impingement Element
-145	.020	MMH	150	1.6	Amb	Amb	100	0.432	1129	231	235	10/25/74	5.6	400	Push 1 Stop	14	Long Impingement Element
-146	.020	MMH	200	1.6	Amb	Amb	100	0.432	1568	281	285	10/25/74	5.6	400	Push 1 Stop	14	Long Impingement Element

Test No.	D_f	Fuel	P_c	MR	T_F	T_o	ΔP_f	Noz	(PSIG)	(PSIG)	(PSIG)	DATE	f-Stop	FR/Rate (PPS)	Process	W/2·N.D.F.	REMARKS
OC-27-147	.020	MMH	250	1.6	Amb	Amb	100	0.330	1095	331	335	10/25/74	5.6	400	Push 1 Stop	14	Long Impingement Element
-148	.020	MMH	100	1.6	Amb	Amb	20	0.563	2110	101	105	10/25/74	5.6	400	Push 1 Stop	14	Long Impingement Element
-149	.020	MMH	100	1.6	Amb	Amb	100	0.563	1350	181	185	10/25/74	5.6	400	Push 1 Stop	14	Long Impingement Element
-150	.020	MMH	300	1.6	Amb	Amb	100	0.330	1350	381	385	10/25/74	5.6	400	Push 1 Stop	14	Long Impingement Element
-151	.020	MMH	500	1.6	Amb	Amb	100	0.265	1463	581	585	10/25/74	5.6	400	Push 1 Stop	14	Long Impingement Element
-152	.020	MMH	1000	1.6	Amb	Amb	100	0.187	1463	1081	1085	10/25/74	3.6	400	Push 1 Stop	14	Long Impingement Element

HIGH PERFORMANCE N_2O_4/AMINE ELEMENTS

Table E-I – TEST CONDITION LOG

Test No.	D_f	Fuel	P_c	MR	T_F	T_o	ΔP_f	Noz	P_{N_2} (psig)	P_{OT} (psig)	P_{FT} (psig)	Date	f-Stop	FR/Rate (PPS)	Process.	Light Meter W/2 N.D.F.	Film Roll No.	Remarks
OC-27-153	0.020	MMH	100	1.6	Amb.	Amb.	10	0.432	1238	94	95	11/22/74	5.6	400	Normal	14-1/2	20	Added Lens Tube to Increase Magnification
154	0.020	MMH	100	1.6	Amb.	Amb.	10	0.432	1238	94	91	11/22/74	5.6	400	Normal	14-1/2		
155	0.020	MMH	100	1.6	Amb.	Amb.	20	0.563	2110	104	102	11/22/74	5.6	400	Normal	14-1/2		
156	0.020	MMH	100	1.6	Amb.	Amb.	40	0.563	2000	123	125	11/22/74	5.6	400	Normal	14-1/2		
157	0.020	MMH	100	1.6	Amb.	Amb.	40	0.563	1900	123	123	11/22/74	5.6	400	Normal	14-1/2		
158	0.020	MMH	100	1.6	Amb.	Amb.	10	0.432	1238	94	91	11/25/74	5.6	400	Normal	14-1/2	21	
159	0.020	MMH	100	1.6	Amb.	Amb.	10	0.432	1238	94	94	11/25/74	5.6	400	Normal	14-1/2		
160	0.020	MMH	100	1.6	Amb.	Amb.	20	0.563	2110	104	104	11/25/74	5.6	400	Normal	14-1/2		
161	0.020	MMH	100	1.6	Amb.	Amb.	20	0.563	2110	104	107	11/25/74	5.6	400	Normal	14-1/2		
162	0.020	MMH	100	1.6	Amb.	Amb.	20	0.563	2110	107	103	11/25/74	5.6	400	Normal	14-1/2		
163	0.020	MMH	100	1.6	Amb.	Amb.	40	0.563	1800	125	125	11/25/74	5.6	400	Normal	14-1/2	22	
164	0.020	MMH	100	1.6	Amb.	Amb.	30	0.563	1900	115	115	11/25/74	5.6	400	Normal	14-1/2		
165	0.020	MMH	100	1.6	Amb.	Amb.	60	0.563	1600	145	145	11/25/74	5.6	400	Normal	14-1/2		
166	0.020	MMH	100	1.6	Amb.	Amb.	100	0.563	1350	185	185	11/25/74	5.6	400	Normal	14-1/2		
167	0.020	MMH	100	1.6	Amb.	Amb.	30	0.563	1900	115	115	12/6/74	3.3	4000	Push 1 Stop	14-1/2	23	
168	0.020	MMH	100	1.6	Amb.	Amb.	30	0.563	1900	115	115	12/6/74	3.3	4000	Push 1 Stop	14-1/2	24	
169	0.020	MMH	100	1.6	Amb.	Amb.	30	0.563	1900	115	115	12/9/74	-	-	-	-		Repeat of #168 - No Film
170	0.020	MMH	100	1.6	Amb.	Amb.	150	0.563	1100	235	235	12/9/74	3.3	4000	Push 1 Stop	14-1/2	25	
171	0.020	MMH	100	1.6	Amb.	Amb.	150	0.563	1264	235	235	12/9/74	5.6	400	Normal	14-1/2	26	Repeat of #170
172	0.020	MMH	200	1.6	Amb.	Amb.	20	0.330	1268	205	205	12/9/74	5.6	400	Normal	14-1/2	26	
173	0.020	MMH	200	1.6	Amb.	Amb.	20	0.330	1268	205	210	12/9/74	5.6	400	Normal	14-1/2	26	Repeat of -172

Test No.	D_f	Fuel	P_c	MR	T_F	T_o	ΔP_f	Noz	P_{N_2} (psig)	P_{CT} (psig)	P_{FT} (psig)	Date	f-Stop	FR/Rate (PPS)	Process.	Light Meter W/2 N.D.F.	Film Roll No.	Remarks
0C-27-174	0.020	MMH	200	1.6	Amb.	Amb.	40	0.330	1184	220	225	12/9/74	5.6	400	Normal	14-1/2	26	
175	0.020	MMH	200	1.6	Amb.	Amb.	60	0.432	1896	240	245	12/9/74	5.6	400	Normal	14-1/2	26	
176	0.020	MMH	100	1.6	Amb.	Amb.	30	0.563	1900	115	116	12/13/74	3.3	4000	Push 1 Stop	14-1/2	27	Changed Lense to 75 MM Repeat of 169
177	0.020	MMH	100	1.6	Amb.	Amb.	30	0.563	1900	115	116	12/13/74	3.3	10,000	Normal	14-1/2	28	Changed Shutter to 1/20th
178	0.020	MMH	100	1.6	Amb.	Amb.	30	0.563	1900	115	116	12/13/74	3.3	10,000	Normal	14-1/2	29	Repeat of 177
179	0.020	MMH	100	1.6	Amb.	Amb.	30	0.563	1900	115	116	12/17/74	5.6	400	Normal	15	30	
180	0.020	MMH	200	1.6	Amb.	Amb.	30	0.330	1200	215	215	12/17/74	5.6	400	Normal	15	30	
181	0.020	MMH	300	1.6	Amb.	Amb.	30	0.330	1850	310	315	12/17/74	5.6	400	Normal	15	30	
182	0.020	MMH	300	1.6	Amb.	Amb.	30	0.330	700	310	315	12/17/74	5.6	400	Normal	15	30	
183	0.020	MMH	300	1.6	Amb.	Amb.	30	0.330	1500	310	315	12/17/74	5.6	400	Normal	15	30	
184	0.020	MMH	300	1.6	Amb.	Amb.	30	0.265	930	310	315	12/18/74	5.6	400	Normal	15	31	
185	0.020	MMH	300	1.6	Amb.	Amb.	30	0.265	1300	310	315	12/18/74	5.6	400	Normal	15	31	
186	0.020	MMH	300	1.6	Amb.	Amb.	30	0.130	0.0	280	285	12/18/74	5.6	400	Normal	15	31	
187	0.020	MMH	300	1.6	Amb.	Amb.	20	0.330	1942	304	305	12/18/74	5.6	400	Normal	15	31	
188	0.020	MMH	300	1.6	Amb.	Amb.	40	0.330	1783	320	325	12/18/74	5.6	400	Normal	15	31	
189	0.020	MMH	300	1.6	Amb.	Amb.	100	0.330	1350	380	385	12/18/74	5.6	400	Normal	15	32	
190	0.020	MMH	100	1.6	100	Amb.	30	0.563	1900	114	116	12/18/74	5.6	400	Normal	15	32	
191	0.020	MMH	100	1.6	100	Amb.	30	0.563	1900	114	116	12/18/74	5.6	400	Normal	15	32	

Test No.	D_f	Fuel	P_c	MR	T_F	T_o	ΔP_f	Noz	P_{N_2} (psig)	P_{OT} (psig)	P_{FT} (psig)	Date	f-Stop	FR/Rate (PPS)	Process.	Light Meter W/2 N.D.F.	Film Roll No.	Remarks
OC-27-192	0.020	MMH	100	1.6	150	Amb.	30	0.563	1900	114	116	12/18/74	5.6	400	Normal	15	32	
193	0.020	MMH	100	1.6	175	Amb.	30	0.563	1900	114	116	12/18/74	5.6	400	Normal	15	32	
194	0.020	MMH	100	1.6	200	Amb.	30	0.563	1900	114	116	12/18/74	5.6	400	Normal	15	33	
195	0.020	MMH	200	1.6	200	Amb.	30	0.330	1200	214	215	12/18/74	5.6	400	Normal	15	33	
196	0.020	MMH	200	1.6	175	125	30	0.330	1200	214	215	12/18/74	5.6	400	Normal	15	33	
197	0.020	MMH	200	1.6	Amb.	150	30	0.330	1200	214	215	12/18/74	5.6	400	Normal	15	33	
198	0.020	A-50	100	1.65	Amb	Amb	10	0.166	N/A	94	95	1/17/75	4	800	Normal	13	34	Changed Shutter to 1/50-no purge
199	0.020	A-50	100	1.65	Amb	Amb	20	0.196	N/A	104	105	1/17/75	4	800	Normal	13	34	Film Broke
200	0.020	A-50	100	1.65	Amb	Amb	20	0.196	N/A	105	105	1/20/75	4	800	Normal	13	35	Repeat of #199
201	0.020	A-50	100	1.65	Amb	Amb	30	0.213	N/A	115	115	1/20/75	4	800	Normal	13	35	
202	0.020	A-50	100	1.65	Amb	Amb	60	0.257	N/A	145	145	1/20/75	4	800	Normal	13	35	
203	0.020	A-50	100	1.65	Amb	Amb	100	0.290	N/A	185	185	1/20/75	4	800	Normal	13	35	
204	0.020	A-50	100	1.65	Amb	Amb	150	0.333	N/A	235	235	1/20/75	4	800	Normal	13	35	
205	0.020	A-50	200	1.65	Amb	Amb	20	0.129	N/A	205	205	1/20/75	4	800	Normal	13	36	
206	0.020	A-50	200	1.65	Amb	Amb	30	0.150	N/A	215	215	1/20/75	3.3	800	Normal	13	36	
207	0.020	A-50	200	1.65	Amb	Amb	150	0.234	N/A	335	335	1/20/75	4	800	Normal	13	36	
208	0.020	A-50	300	1.65	Amb	Amb	20	0.113	N/A	305	305	1/20/75	4	800	Normal	13	36	T/C Probe Malfunction
209	0.020	A-50	300	1.65	Amb	Amb	20	0.113	N/A	305	305	1/20/75	3.3	800	Normal	N/A	36	Strobe Light on Bottom
210	0.020	A-50	300	1.65	Amb	Amb	20	0.113	N/A	305	305	1/20/75	4.0	800	Normal	N/A	36	Strobe Light in back

Test No.	D_f	Fuel	P_c	MR	T_F	T_o	ΔP_f	Noz	P_{N_2} (psig)	P_{OT} (psig)	P_{FT} (psig)	Date	f-Stop	FR/Rate (PPS)	Process.	Light Meter W/2 N.D.F.	Film Roll No.	Remarks
OC-27-211	0.020	A-50	300	1.65	Amb	Amb	20	0.113	N/A	305	305	1/21/75	4.0	800	Normal	13	37	
212	0.020	A-50	300	1.65	Amb	Amb	30	0.125	N/A	315	315	1/21/75	4.0	800	Normal	13	37	T/C shows bi-level mode
213	0.020	A-50	300	1.65	Amb	Amb	60	0.150	N/A	345	345	1/21/75	4.0	800	Normal	13	37	
214	0.020	A-50	300	1.65	Amb	Amb	100	0.166	N/A	385	385	1/21/75	4.0	800	Normal	13	37	
215	0.020	A-50	300	1.65	Amb	Amb	150	0.189	N/A	435	435	1/21/75	4.0	800	Normal	13	37	
216	0.020	A-50	500	1.65	Amb	Amb	60	0.113	N/A	545	545	1/21/75	4.0	800	Normal	13	38	
217	0.020	A-50	500	1.65	Amb	Amb	100	0.129	N/A	585	585	1/21/75	4.0	800	Normal	13	38	
218	0.021	MMH	125	1.65	Amb	Amb	50	0.166	N/A	150	160	1/31/75	4.0	800	Normal	13	39	XDT-1 Platelet Inj.
219	0.021	MMH	125	1.65	Amb	Amb	50	0.189	N/A	160	160	1/31/75	4.0	800	Normal	13	39	
220	0.021	MMH	100	1.65	Amb	Amb	30	0.189	N/A	116	116	1/31/75	4.0	800	Normal	13	39	
221	0.021	MMH	80	1.65	Amb	Amb	20	0.189	N/A	85	85	1/31/75	4.0	800	Normal	13	39	
222	0.021	MMH	150	1.65	Amb	Amb	70	0.189	N/A	206	206	1/31/75	4.0	800	Normal	13	39	
223	0.021	MMH	200	1.65	Amb	Amb	125	0.189	N/A	311	311	1/31/75	4.0	800	Normal	13	39	
224	0.021	MMH	125	1.65	170	Amb	50	0.189	N/A	160	160	2/4/75	3.3	800	Normal	13	40	XDT-1
225	0.021	MMH	125	1.65	170	Amb	50	0.189	N/A	160	160	2/4/75	3.3	800	Normal	13	40	Repeat of #224
226	0.021	MMH	125	1.65	240	Amb	50	0.189	N/A	160	160	2/4/75	3.3	800	Normal	13	40	
227	0.021	MMH	125	1.65	290	125	50	0.189	N/A	160	160	2/4/75	3.3	800	Normal	13	40	Windows not cleaned - T_i Malf.
228	0.021	MMH	150	1.65	290	125	50	0.189	N/A	206	206	2/4/75	3.3	800	Normal	13	40	Windows not cleaned
229	0.021	MMH	125	1.65	290	125	50	0.189	N/A	160	160	2/6/75	4.0	800	Normal	13	41	XDT-1
230	0.021	MMH	125	1.65	290	125	50	0.189	N/A	160	160	2/6/75	4.0	800	Normal	13	41	
231	0.021	MMH	150	1.65	290	125	50	0.189	N/A	160	160	2/6/75	4.0	800	Normal	13	41	Windows not cleaned

Test No.	D_f	Fuel	P_c	MR	T_F	T_o	ΔP_f	Noz	P_{N_2} (psig)	P_{OT} (psig)	P_{FT} (psig)	Date	f-Stop	FR/Rate (FPS)	Process.	Light Meter W/2 N.D.F.	Film Roll No	Remarks
OC-27-232	0.021	MMH	150	1.65	290	150	50	0.189	N/A	160	160	2/6/75	4.0	800	Normal	13	41	Windows not cleaned
233	0.021	MMH	150	1.65	290	150	50	0.189	N/A	160	160	2/6/75	4.0	800	Normal	13	41	Windows not cleaned
234	0.021	MMH	125	1.65	Amb	Amb	65	0.189	N/A	175	175	2/6/75	4.0	800	Normal	13	42	Splash Plate - Spikes
235	0.021	MMH	100	1.65	Amb	Amb	42	0.189	N/A	127	127	2/6/75	4.0	800	Normal	13	42	Instru. Malf. Spikes
236	0.021	MMH	100	1.65	Amb	Amb	42	0.189		127	127	2/6/75	4.0	800	Normal	13	42	Repeat of #235
237	0.021	MMH	80	1.65	Amb	Amb	27	[illegible]	N/A	92	92	2/6/75	4.0	800	Normal	13	42	
238	0.021	MMH	150	1.65	Amb	Amb	95	0.189	N/A	230	230	2/6/75	4.0	800	Normal	13	42	T_i Malf.
239	0.021	MMH	200	1.65	Amb	Amb	168	0.189	N/A	353	353	2/6/75	4.0	800	Normal	13	42	Window not cleaned
240	0.021	MMH	150	1.65	Amb	Amb	95	0.189	N/A	230	230	2/10/75	4.0	800	Normal	13	43	Manifold & Pc Spikes
241	0.021	MMH	150	1.65	Amb	Amb	[illegible]	0.189	N/A	230	230	2/10/75	5.6	800	Normal	13	43	No Spikes
242	0.021	MMH	150	1.65	Amb	Amb	95	0.189	N/A	230	230	2/10/75	8.0	800	Normal	13	43	
243	0.021	MMH	200	1.65	Amb	Amb	168	0.189	N/A	35[illegible]	[illegible]53	2/10/75	4.0	800	Normal	13	43	
244	0.021	MMH	125	1.65	170	Amb	65	0.189	N/A	75		/10/75	4.0	800	Normal	13	43	Spike on ox manifold
245	0.021	MMH	125	1.65	240	Amb	65	0.189	N/A	175	175	2/10/75	4.0	800	Normal	13	44	
246	0.021	MMH	125	1.65	290	125	65	0.189	N/A	175	175	2/10/75	4.0	800	Normal	13	44	
247	0.021	MMH	150	1.65	290	125	95	0.189	N/A	230	230	2/10/75	4.0	800	Normal	13	44	Spikes in manifolds
248	0.021	MMH	150	1.65	290	150	95	0.189	N/A	230	230	2/10/75	4.0	800	Normal	13	43	Spikes in manifolds
249	0.021	MMH	150	1.65	290	150	95	0.189	N/A	230	230	2/10/75	8.0	800	Normal	13	43	Spikes in manifolds

Test No.	D_f	Fuel	P_c	MR	T_F	T_o	ΔP_f	Noz	P_{N_2} (psig)	P_{OT} (psig)	P_{FT} (psig)	Date	f-Stop	FR/Rate (PPS)	Process.	Light Meter W/2 N.D.F.	Film Roll No.	Remarks
OC-27-250	0.0295	MMH	125	1.65	Amb	Amb	45	0.365	N/A	160	155	2/14/75	4.0	800	Normal	13	45	Triplet-No O-Graph
251	0.0295	MMH	125	1.65	Amb	Amb	45	0.365	N/A	160	155	2/14/75	4.0	800	Normal	13	45	Repeat of 250
252	0.0295	MMH	100	1.65	Amb	Amb	27	0.365	N/A	114	112	2/14/75	4.0	800	Normal	13	45	
253	0.0295	MMH	80	1.65	Amb	Amb	17	0.365	N/A	84	82	2/14/75	4.0	800	Normal	13	45	
254	0.0295	MMH	150	1.65	Amb	Amb	61	0.365	N/A	202	196	2/14/75	4.0	800	Normal	13	45	
255	0.0295	MMH	200	1.65	Amb	Amb	108	0.365	N/A	303	293	2/14/75	4.0	800	Normal	13	45	
256	0.0295	MMH	125	1.65	170	Amb	45	0.365	N/A	160	155	2/14/75	4.0	800	Normal	13	46	
257	0.0295	MMH	125	1.65	240	Amb	45	0.365	N/A	160	155	2/14/75	4.0	800	Normal	13	46	
258	0.0295	MMH	125	1.65	290	125	45	0 365	N/A	160	155	2/14/75	4.0	800	Normal	13	46	
259	0.0295	MMH	150	1.65	290	125	61	0.365	N/A	202	196	2/14/75	4 0	800	Normal	13	46	
260	0.0295	MMH	150	1.65	290	150	61	0.365	N/A	202	196	2/14/75	4.0	800	Normal	13	46	
261	0.020	Water	14.7	1.65	Amb	Amb	10	N/A	200	20	10	2/21/75	4.0	800	Normal	13	47	Water/Freon Cold Flow with unlike doublet
262	0.020	Water	14.7	1.65	Amb	Amb	20	N/A	200	20	20	2/21/75	4.0	800	Normal	13	47	
263	0.020	Water	14.7	1.65	Amb	Amb	40	N/A	200	40	40	2/21/75	4.0	800	Normal	13	48	
264	0.020	Water	14.7	1.65	Amb	Amb	60	N/A	200	60	60	2/21/75	4.0	800	Normal	13	48	
265	0.020	Water	14.7	1.65	Amb	Amb	80	N/A	200	80	80	2/21/75	4.0	800	Normal	13	48	
266	0.020	Water	14.7	1.65	Amb	Amb	100	N/A	200	100	100	2/21/75	4.0	800	Normal	13	48	
267	0.020	Water	14.7	1.65	Amb	Amb	150	N/A	200	150	150	2/21/75	4.0	800	Normal	13	48	
268	0.020	Water	14.7	1.65	Amb	Amb	200	N/A	200	200	200	2/21/75	4.0	800	Normal	13	48	
269	0.020	Water	14.7	1.65	Amb	Amb	20	N/A	200	20	20	2/21/75	4.0	2000	Normal	N/A	49	Changed Shutter to 1/10th with strobe backlight
270	0.020	Water	14.7	1.65	Amb	Amb	40	N/A	200	40	40	2/21/75	4.0	2000	Normal	N/A	49	
271	0.020	Water	14.7	1.65	Amb	Amb	60	N/A	200	60	60	2/21/75	4.0	2000	Normal	N/A	49	
272	0.020	Water	14.7	1.65	Amb	Amb	100	N/A	200	100	100	2/21/75	4.0	2000	Normal	N/A	50	
273	0.020	Water	14.7	1.65	Amb	Amb	150	N/A	200	150	150	2/21/75	4.0	2000	Normal	N/A	50	
274	0.020	Water	14.7	1.65	Amb	Amb	100	N/A	200	100	100	2/21/75	3.3	2000	Normal	N/A	50	

Test No.	D_f	Fuel	P_c	MR	T_F	T_o	ΔP_f	Noz	P_{N_2} (psig)	P_{OT} (psig)	P_{FT} (psig)	Date	f-Stop	FR/Rate (PPS)	Process.	Light Meter W/2 N.D.F.	Film Roll No.	Remarks
OC-27-275	0.020	MMH	125	1.65	70	70	50	0.269	N/A	160	160	2/27/75	4.00	800	Normal	13	51	Small Dia. Triplet
276	0.020	MMH	125	1.65	70	70	50	0.269	N/A	156	162	2/27/75	4.00	800	Normal	13	51	Repeat of 275
277	0.020	MMH	100	1.65	70	70	30	0.269	N/A	113	115	2/27/75	4.00	800	Normal	13	51	
278	0.020	MMH	80	1.65	70	70	20	0.269	N/A	84	85	2/27/75	4.00	800	Normal	13	51	
279	0.020	MMH	150	1.65	70	70	70	0.269	N/A	200	209	2/27/75	4.00	800	Normal	13	51	
280	0.020	MMH	200	1.65	70	70	125	0.269	N/A	300	310	2/27/75	4.00	800	Normal	13	51	
281	0.020	MMH	125	1.65	170	70	50	0.269	N/A	156	162	2/27/75	4.00	800	Normal	13	52	
282	0.020	MMH	125	1.65	240	70	50	0.269	N/A	156	162	2/27/75	4.00	800	Normal	13	52	
283	0.020	MMH	125	1.65	240	79	50	0.269	N/A	156	162	2/27/75	4.00	800	Normal	13	52	Repeat of 281
284	0.020	MMH	125	1.65	290	125	50	0.259	N/A	156	162	2/27/75	4.00	800	Normal	13	52	
285	0.020	MMH	150	1.65	290	125	70	0.269	N/A	200	210	2/27/75	4.00	800	Normal	13	52	
286	0.020	MMH	150	1.65	290	150	70	0.269	N/A	200	210	2/27/75	4.00	800	Normal	13	52	
287	0.020	MMH	125	1.65	Amb	Amb	30	0.189	N/A	140	140	3/4/75	4.00	800	Normal	13	53	Unlike Doub.
288	0.020	MMH	100	1.65	Amb	Amb	18	0.189	N/A	103	103	3/4/75	4.00	800	Normal	13	53	
289	0.020	MMH	80	1.65	Amb	Amb	12	0.189	N/A	77	77	3/4/75	4.00	800	Normal	13	53	
290	0.020	MMH	80	1.65	Amb	Amb	12	0.189	N/A	77	77	3/4/75	4.00	800	Normal	13	53	Repeat of 289
291	0.020	MMH	150	1.65	Amb	Amb	40	0.189	N/A	175	175	3/4/75	4.00	800	Normal	13	53	
292	0.020	MMH	200	1.65	Amb	Amb	75	0.189	N/A	260	260	3/4/75	4.00	800	Normal	13	53	
293	0.020	MMH	125	65	170	Amb	30	0.189	N/A	140	140	3/4/75	4.00	800	Normal	13	54	
294	0.020	MMH	125	1.65	240	Amb	30	0.189	N/A	140	140	3/4/75	4.00	800	Normal	13	54	
295	0.020	MMH	125	1.65	240	125	30	0.189	N/A	140	140	3/4/75	4.00	800	Normal	13	54	
296	0.020	MMH	150	1.65	290	125	40	0.189	N/A	175	175	3/4/75	4.00	800	Normal	13	54	
297	0.020	MMH	150	1.65	290	150	40	0.189	N/A	175	175	3/4/75	4.00	800	Normal	13	54	

TABLE E-II - TEST RESULT SUMMARY

Test No.	P_c (psia)	P_{OJ} (psia)	P_{FJ} (psia)	ΔP_{OJ} (psi)	ΔP_{FJ} (psi)	$\dot{W}_o$ (lb/sec)	$\dot{W}_f$ (lb/sec)	T_{OJ} °F	T_{FJ} °F	MR
OC-27-101	308	406	401	98	93	.0252	.0152	88	87	1.66
-102	308	400	406	92	98	.0245	.0156	88	87	1.57
-103	309	404	404	95	95	.0249	.0153	88	87	1.62
-104	[illegible]11	404	404	93	93	.0246	.0152	88	87	1.62
-105	507	605	595	98	88	.0252	.01[illegible]	89	88	1.70
-106	1000	1101	1108	101	108	.0256	.0163	89	88	1.[illegible]
-107	308	404	395	96	87	.0250	.0147	86	85	1.7
-108	263	353	350	90	87	.0242	.0147	84	84	1.65
-109	197	305	302	108	105	.0265	.0161	84	84	1.64
-110	158	251	253	93	95	.0246	.0153	83	83	1.60
-111	100	202	204	102	104	.0258	.0160	84	83	1.60
-112	89	121	122	32	33	.0144	.00965	76	76	1.59
-113	101	201	197	100	97	.0255	.0156	88	87	1.63
-114	162	250	245	88	[illegible]3	.0239	.0144	82	82	1.66
-115	203	303	298	100	95	.0255	.0154	81	78	1.65
-116	269	353	347	84	78	.0234	.0140	80	77	1.67
-117	301	347	345	46	44	.0173	.0105	78	76	1.64
-118	310	401	401	91	91	.0243	.015[illegible]	81	81	1.60
-119	510	599	596	89	86	.0240	.0147	82	82	1.64
-120	1003	1096	1093	93	90	.0246	.0150	82	81	1.63

Test No.	P_c (psia)	P_{OJ} (psia)	P_{FJ} (psia)	ΔP_{OJ} (psi)	ΔP_{FJ} (psi)	$\dot{W}_o$ (lb/sec)	$\dot{W}_f$ (lb/sec)	T_{OJ} °F	T_{FJ} °F	MR
OC-27-121	160	255	254	95	94	.0249	.0153	81	80	1.62
-122	338	402	399	64	61	.0204	.0123	81	80	1.65
-123	334	403	400	69	66	.0212	.0128	77	77	1.65
-124	955	1016	1021	66	61	.0195	.0120	82	82	1.61
-125	495	601	595	106	100	.0248	.0154	83	81	1.60
-126	298	404	400	106	102	.0248	.0156	83	82	1.59
-127	283	322	321	39	38	.0150	.00952	84	81	1.58
-128	256	353	350	97	94	.0237	.0149	85	83	1.58
-129	191	304	299	113	108	.0256	.0160	85	83	1.60
-130	152	252	251	100	99	.0240	.0153	85	82	1.56
-131	95	201	199	106	104	.0248	.0157	85	83	1.57
-132	114	226	223	112	109	.0255	.0161	86	83	1.58
-133	411	602	595	191	184	.0352	.0212	83	83	1.66
-134	97	202	197	105	100	.0261	.0150	77	197	1.74
-135	119	226	223	107	104	.0264	.0153	78	199	1.72
-136	150	254	249	104	99	.0260	.0150	77	199	1.74
-137	188	304	298	116	110	.0275	.0158	76	199	1.74
-138	243	349	353	106	110	.0262	.0164	79	195	1.60
-139	103	119	123	16	20	.0102	.0070	61	59	1.455
-140	81	199	201	118	120	.0277	.0171	64	62	1.61
-141	81	197	201	116	120	.0275	.0171	66	64	1.60
-142	119	222	227	103	108	.0259	.0163	68	67	1.59
-143	129	142	146	13	17	.00920	.00646	67	67	1.42
-144	154	170	172	16	18	.0102	.00664	67	67	1.53
-145	152	248	248	96	96	.0250	.0153	68	67	1.62

Table E-II (cont.)

Test No.	P_c (psia)	P_{OJ} (psia)	P_{FJ} (psia)	ΔP_{OJ} (psi)	ΔP_{FJ} (psi)	$\dot{W}_o$ (lb/sec)	$\dot{W}_f$ (lb/sec)	T_{OJ} °F	T_{FJ} °F	MR
OC-27-146	190	298	298	108	108	.0256	.0162	68	67	1.57
-147	258	347	348	89	90	.0240	.0148	68	67	1.61
-148	102	119	122	17	20	.0105	.00700	68	68	1.49
-149	99	198	202	99	103	.0254	.0159	69	69	1.60
-150	297	397	398	100	101	.0255	.0157	70	69	1.62
-151	484	596	594	112	110	.0270	.0164	70	69	1.64
-152	958	1084	1085	126	127	.0286	.0176	78	74	1.62

Table E-II (cont.)

Test No.	P_c (psia)	P_{OJ} (psia)	P_{FJ} (psia)	ΔP_{OJ} (psi)	ΔP_{FJ} (psi)	$\dot{W}_o$ (lb/sec)	$\dot{W}_f$ (lb/sec)	T_{OJ} (°F)	T_{FJ} (°F)	MR
OC-27-153	98.3	108.9	113.0	10.6	14.7	0.00831	0.00604	55	56	1.38
154	99.5	110.4	109.7	10.9	10.2	0.00843	0.00503	54	55	1.68
155	102.0	119.1	117.4	17.0	15.4	0.01056	0.00617	54	54	1.72
156	106.8	137.4	141.3	30.6	34.5	0.01416	0.00926	53	54	1.53
157	101.7	137.7	138.1	36.1	36.5	0.01537	0.00951	53	54	1.62
158	100.6	111.1	108.0	10.5	7.4	0.00826	0.00427	58	58	1.94
159	98.7	110.2	109.3	11.5	10.7	0.00868	0.00515	57	58	1.69
160	100.8	120.0	119.4	19.2	18.5	0.01121	0.00678	57	58	1.66
161	101.8	119.7	121.4	18.0	19.6	0.01083	0.00698	58	58	1.55
162	102.4	123.8	119.2	21.5	16.9	0.01184	0.00647	57	58	1.83
163	98.3	141.1	140.1	42.9	41.9	0.01674	0.01020	58	58	1.65
164	100.1	131.6	130.2	31.5	30.1	0.01434	0.00864	56	57	1.66
165	95.0	160.6	161.0	65.7	66.0	0.02072	0.01280	56	57	1.62
166	94.9	201.3	199.4	106.4	104.5	0.02637	0.01610	56	57	1.64
167	98.2	132.1	131.1	33.0	31.9	0.014[illegible]	0.00890	55	55	1.65
168	98.6	132.0	130.9	33.4	32.4	0.01478	0.00897	55	55	1.65
169	95.2	130.4	128.1	35.2	33.0	0.01523	0.00907	44	44	1.68
170	88.7	249.4	246.2	157.6	160.7	0.03254	0.01983	44	44	1.64
171	94.8	251.4	246.5	156.6	151.7	0.03212	0.01945	44	44	1.65
172	196.5	221.9	215.8	25.4	19.3	0.01295	0.00695	44	44	1.87
173	197.7	222.5	220.7	24.8	23.0	0.01278	0.00758	44	44	1.69
174	201.2	236.9	236.4	35.2	35.2	0.01534	0.00937	43	44	1.64
175	192.2	256.2	254.1	64.1	61.9	0.02055	0.01243	43	44	1.66
176	96.7	131.2	130.0	34.5	33.3	0.01505	0.00911	50	50	1.66
177	97.2	131.9	129.6	34.6	32.3	0.01508	0.00897	48	49	1.68
178	95.7	128.0	126.7	32.2	31.0	0.01456	0.00878	47	48	1.66
179	97.2	131.1	129.5	33.9	32.3	0.01485	0.00893	64	68	1.67
180	201.9	232.2	229.7	30.4	27.8	0.01403	0.00828	66	71	1.70
181	295.4	327.0	327.8	31.6	32.4	0.01431	0.00892	67	73	1.60
182	181.8	327.6	327.0	145.8	145.2	0.03066	0.01885	75	78	1.62
183	197.9	327.5	327.8	129.5	129.8	0.02889	0.01784	76	77	1.62

Table E-II (cont.)

Test No.	P_c (psia)	P_{OJ} (psia)	P_{FJ} (psia)	ΔP_{OJ} (psi)	ΔP_{FJ} (psi)	$\dot{W}_o$ (lb/sec)	$\dot{W}_f$ (lb/sec)	T_{OJ} (°F)	T_{FJ} (°F)	MR
OC-27-184	259.0	323.3	327.1	64.3	68.0	0.02041	0.01296	71	70	1.57
185	269.3	327.8	326.4	58.5	57.1	0.01948	0.01187	70	70	1.64
186	261.9	293.3	298.1	31.4	36.2	0.01428	0.00944	69	70	1.51
187	292.9	317.1	315.3	24.2	22.4	0.01254	0.00744	68	69	1.69
188	300.0	335.9	337.6	35.9	37.6	0.01526	0.00963	70	70	1.58
189	294.9	394.0	400.2	99.1	105.3	0.02531	0.01611	73	72	1.57
190	99.2	131.1	130.8	31.9	31.6	0.01442	0.00880	64	82	1.64
191	97.9	131.4	131.4	33.5	33.5	0.01460	0.00903	62	93	1.64
192	98.4	131.5	130.4	33.1	32.0	0.01465	0.00867	71	149	1.69
193	98.0	131.5	130.2	32.6	31.3	0.01448	0.00851	78	177	1.70
194	99.2	133.7	131.8	34.5	32.7	0.01487	0.00862	80	200	1.73
195	201.5	232.1	229.0	30.5	27.4	0.01398	0.00791	82	196	1.77
196	202.4	231.5	229.4	29.1	27.0	0.01339	0.00790	124	178	1.69
197	202.4	231.3	228.3	28.9	26.0	0.01345	0.00796	112	89	1.69
198	92.4	109.4	108.4	17.0	16.0	0.0105	0.00637	53	60	1.64
199	94.3	119.7	120.2	25.4	25.9	0.0128	0.00811	74	85	1.58
200	88.5	120.	119.8	31.5	31.3	0.0143	0.00891	65	75	1.60
201	96.8	131.4	131.5	34.6	34.7	0.0149	0.00938	68	73	1.59
202	81.0	159.7	159.5	78.7	78.2	0.0226	0.0140	69	74	1.61
203	101.8	202.6	198.8	100.8	97.0	0.0255	0.0156	72	72	1.63
204	94.8	247.8	242.8	153.	148.0	0.0315	0.0193	70	70	1.63
205	201.2	222.5	215.9	21.3	1477	0.0117	0.00611	66	68	1.01
206	198.5	231.2	228.1	32.7	29.6	0.0145	0.00867	77	69	1.67
207	193.0	353.0	348.	160	155	0.0320	0.0198	80	81	1.61
208	295.0	320.2	319.7	25.2	24.7	0.0127	0.00792	70	74	1.60
209	291	314.8	315.6	23.8	24.6	0.0124	0.00790	63	63	1.57
210	293	315.3	314.5	22.3	21.5	0.0120	0.00739	61	64	1.62
211	290	313.6	317.1	23.0	27.1	0.0122	0.00829	62	68	1.47
212	290	325.6	324.4	35.6	34.4	0.0151	0.00934	78	84	1.61
213	289	357.1	356.0	68.1	67.0	0.0209	0.0130	76	79	1.60
214	293	395	395	102	102	0.0256	0.0160	75	77	1.60
215	292	447	450	155	158	0.0319	0.020	71	75	1.59
216	489	554.9	553.7	65.9	64.7	0.0205	0.0128	68	70	1.60
217	491	598.7	597.8	107.7	106.8	0.0263	0.0164	68	68	1.60

Table E-II (cont.)

Test No.	P_c (psia)	P_{OJ} (psia)	P_{FJ} (psia)	ΔP_{OJ} (psi)	ΔP_{FJ} (psi)	$\dot{W}_o$ (lb/sec)	$\dot{W}_f$ (lb/sec)	T_{OJ} (°F)	T_{FJ} (°F)	MR
OC-27-218	135	176.7	175.7	41.7	40.7	.0125	.00745	65	70	1.67
219	124	177.5	174.8	53.5	50.8	.0142	.00832	72	73	1.70
220	98	132.1	133.0	34.1	35.0	.0113	[illegible]	69	71	1.63
221	81	103.3	103.5	22.7	22.9	.0093	.00559	62	68	1.66
222	148	233.1	220.8	75.1	72.8	.0168	.00995	76	75	1.69
223	194	326.0	32.10	132.0	127.0	.0222	.0130	79	97	1.71
224	122	175.7	171.1	53.7	49.1	.01422	.00802	77	141	1.77
225	123	178.1	172.1	55.4	49.4	.0144	.00798	80	164	1.80
226	122	176.6	171.4	54.3	49.1	.0142	.0078	93	229	1.82
227	122	176.8	171.1	55.3	49.6	.0141	.0078	116	242	1.81
228	144	219.6	212.1	75.0	68.4	.0165	.00914	127	249	1.80
229	119	177.0	175.4	57.8	56.2	.0145	.00829	109	245	1.75
230	122	177.1	175.5	55.5	53.9	.0141	.00806	120	268	1.75
231	146	224.4	220.9	78.2	74.7	.0166	.00945	136	280	1.76
232	145	224.9	222.8	80.3	78.2	.0166	.00963	162	291	1.72
233	124	180.5	181.5	56.3	57.3	.0140	.00826	153	285	1.69
234	123	190.9	186.9	67.9	63.9	.0138	.0082	73	76	1.68
236	102	142.7	139.5	41.1	37.9	.0107	.00632	71	72	1.69
237	81	109.9	108.4	28.5	27.0	.00896	.00533	74	76	1.68
238	144	244.3	240.2	100.7	96.6	.0168	.0100	78	82	1.68
239	186	367.6	362.4	181.6	176.4	.0225	.0136	79	79	1.65
240	164	245.0	243.9	80.7	79.6	.0150	.00917	74	74	1.64
241	160	246.5	243.3	86.6	83.4	.0156	.00938	77	79	1.66
242	166	246.2	242.2	80.0	76.0	.0150	.00897	78	71	1.67
243	192	368.8	365.5	176.7	173.4	.0222	.0135	78	75	1.64
244	123	193.1	189.9	70.5	67.3	.0140	.00818	79	170	1.72
245	117	192.0	191.2	74.6	73.8	.0144	.00838	85	239	1.72
246	119	192.6	192.0	73.9	73.3	.01399	.00821	136	288	1.70
247	139	245.9	247.3	107.2	108.6	.0169	.0100	132	283	1.69
248	137	248.0	246.0	111.1	109.1	.01699	.0100	153	288	1.69
249	147	247.5	246.0	100.1	98.6	.0161	.00953	154	287	1.69
250	125	174.5	171.1	46.0	42.6	.0578	.0268	73	75	2.15
251	125	174.1	168.2	49.2	43.3	.0598	.0252	70	75	2.37
252	99	128.4	125.5	29.6	26.7	.0464	.0199	68	78	2.33

Table E-II (cont.)

t No.	P_c (psia)	P_{OJ} (psia)	P_{FJ} (psia)	ΔP_{OJ} (psi)	ΔP_{FJ} (psi)	$\dot{W}_o$ (lb/sec)	$\dot{W}_f$ (lb/sec)	T_{OJ} (°F)	T_{FJ} (°F)	MR
OC-27-253	80	100.3	97.9	19.9	17.5	.0381	.0158	72	78	2.41
254	146	212.8	207.7	66.9	61.8	.0698	.0327	72	76	2.13
255	194	310.6	303.3	116.6	109.3	.0921	.0403	71	69	2.28
256	119	172.9	169.6	53.6	50.3	.0523	.0279	77	178	2.23
257	116	173.2	168.9	57.1	52.8	.0644	.0283	76	244	2.27
258	113	173.4	168.7	60.2	55.5	.0641	.0336	140	312	1.90
259	131	213.7	210.0	82.6	78.9	.0752	.0327	120	300	2.31
260	137	213.9	208.5	77.4	72.0	.0720	.0312	153	301	2.30
275	126	174.1	170.9	48.2	44.9	.0282	.0160	59	71	1.76
276	129	169.9	171.5	41.4	42.6	.0259	.0156	78	77	1.66
277	101	125.3	125.9	24.5	25.0	.0200	.0119	71	80	1.67
278	81	98.1	95.3	17.5	14.7	.0169	.00917	71	77	1.84
279	157	211.9	216.3	54.9	59.3	.0300	.0184	71	75	1.63
280	210	303.2	314.5	97.8	104	.0400	.0244	72	73	1.64
281	129	172.3	177.2	43.5	48.4	.0266	.0162	80	150	1.64
282	129	172.6	178.3	44.0	49.6	.0267	.0160	85	226	1.66
283	132	173.1	178.1	41.7	46.7	.0259	.0154	85	250	1.68
284	130	173.1	78.1	43.4	48.4	.0259	.0155	130	287	1.66
285	156	217.3	224.3	61.5	68.4	.0308	.0184	131	296	1.67
286	150	217.2	224.7	66.7	74.3	.0318	.0192	145	297	1.66
287	124	154.3	154	30.1	29.9	.0139	.00857	72	82	1.63
288	98	117.3	117.3	19.0	19.0	.0111	.00684	73	72	1.62
289	78	91.2	92.6	13.0	14.3	.00916	.00594	75	76	1.54
290	78	91.2	91.1	13.6	13.5	.00937	.00576	74	75	1.62
291	147	190.3	188.3	43.0	41.0	.0166	.0100	75	75	1.66
292	198	274.8	272.1	76.8	74.1	.0222	.0135	76	76	1.65
293	123	154.9	154.7	31.7	31.5	.0143	.0085	75	185	1.68
294	123	154.9	153.6	32.2	30.9	.0143	.00827	80	249	1.74
295	121	154.9	155.7	33.7	34.5	.0144	.00875	116	240	1.65
296	145	194.0	192.6	49.1	47.7	.0173	.01011	131	290	1.71
297	144	195.2	196.5	51.5	52.8	.0175	.0106	152	294	1.65

Table E-III

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR LAWVER

FUEL TYPE	TEST NO.	INJECTOR TYPE	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	MODE	REACT (SEC)
MMH	101	UNLIKE-DOUBLET	.024	.020	24.	60.	308.	90.5	129.1	88.	87.	1.66	1.239	SEP	.102-04
MMH	102	UNLIKE-DOUBLET	.024	.020	24.	60.	308.	87.9	132.5	88.	87.	1.57	1.381	SEP	.104-04
MMH	103	UNLIKE-DOUBLET	.024	.020	24.	60.	309.	89.4	129.9	88.	87.	1.62	1.286	SEP	.102-04
MMH	104	UNLIKE-DOUBLET	.024	.020	24.	60.	311.	88.3	129.1	88.	87.	1.62	1.301	SEP	.102-04
MMH	105	UNLIKE-DOUBLET	.024	.020	24.	60.	507.	90.5	125.7	89.	88.	1.70	1.175	SEP	.101-04
MMH	106	UNLIKE-DOUBLET	.024	.020	24.	60.	1000.	92.0	138.5	89.	88.	1.57	1.381	SEP	.112-04
MMH	107	UNLIKE-DOUBLET	.024	.020	24.	60.	308.	89.6	124.7	86.	85.	1.70	1.178	SEP	.934-05
MMH	108	UNLIKE-DOUBLET	.024	.020	24.	60.	263.	86.6	124.6	84.	84.	1.65	1.259	SEP	.899-05
MMH	109	UNLIKE-DOUBLET	.024	.020	24.	60.	197.	94.8	136.5	84.	84.	1.64	1.260	SEP	.985-05
MMH	110	UNLIKE-DOUBLET	.024	.020	24.	60.	158.	87.9	129.6	83.	83.	1.60	1.320	SEP	.911-05
MMH	111	UNLIKE-DOUBLET	.024	.020	24.	60.	100.	92.3	135.5	84.	83.	1.60	1.312	MIX	.964-05
A-50	112	UNLIKE-DOUBLET	.024	.020	24.	60.	89.	51.1	73.9	76.	76.	1.59	1.308	MIX	.716-05
A-50	113	UNLIKE-DOUBLET	.024	.020	24.	60.	101.	91.5	128.0	88.	87.	1.63	1.232	MIX	.168-04
A-50	114	UNLIKE-DOUBLET	.024	.020	24.	60.	162.	85.3	117.9	82.	82.	1.66	1.199	MIX	.133-04
A-50	115	UNLIKE-DOUBLET	.024	.020	24.	60.	203.	91.0	125.9	81.	78.	1.65	1.203	SEP	.133-04
A-50	116	UNLIKE-DOUBLET	.024	.020	24.	60.	269.	83.4	114.4	80.	77.	1.67	1.181	SEP	.117-04
A-50	117	UNLIKE-DOUBLET	.024	.020	24.	60.	301.	61.6	85.7	75.	76.	1.64	1.217	SEP	.851-05
A-50	118	UNLIKE-DOUBLET	.024	.020	24.	60.	310.	86.7	123.6	81.	81.	1.60	1.276	SEP	.135-04
A-50	119	UNLIKE-DOUBLET	.024	.020	24.	60.	510.	85.7	120.4	82.	82.	1.64	1.239	SEP	.136-04
A-50	120	UNLIKE-DOUBLET	.024	.020	24.	60.	1003.	87.8	122.8	82.	81.	1.63	1.227	SEP	.136-04
A-50	121	UNLIKE-DOUBLET	.024	.020	24.	60.	160.	88.8	125.2	81.	80.	1.62	1.247	MIX	.135-04
A-50	122	UNLIKE-DOUBLET	.024	.020	24.	60.	338.	72.8	100.6	81.	80.	1.65	1.200	SEP	.108-04
A-50	123	UNLIKE-DOUBLET	.024	.020	24.	60.	330	75.4	104.6	77.	77.	1.65	1.206	SEP	.104-04
MMH	124	UNLIKE-DOUBLET	.024	.020	24.	60.	955.	69.6	101.6	82.	82.	1.61	1.293	SEP	.695-05
MMH	125	UNLIKE-DOUBLET	.024	.020	24.	60.	495.	89.6	130.3	83.	81.	1.60	1.315	SEP	.890-05
MMH	126	UNLIKE-DOUBLET	.024	.020	24.	60.	298.	[illegible].6	132.1	83.	82.	1.59	1.350	SEP	.915-05
MMH	127	UNLIKE-DOUBLET	.024	.020	24.	60.	283.	53.7	80.5	84.	81.	1.58	1.372	M/S	.557-05
MMH	128	UNLIKE-DOUBLET	.024	.020	24.	60.	256.	84.8	126.2	85.	83.	1.58	1.347	SEP	.909-05
MMH	129	UNLIKE-DOUBLET	.024	.020	24.	60.	191.	91.6	135.5	85.	83.	1.60	1.331	SEP	.976-05
MMH	130	UNLIKE-DOUBLET	.024	.020	24.	60.	152.	85.9	129.5	85.	82.	1.56	1.384	M/S	.920-05
MMH	131	UNLIKE-DOUBLET	.024	.020	24.	60.	95.	88.8	133.0	85.	83.	1.57	1.366	MIX	.958-05
MMH	132	UNLIKE-DOUBLET	.024	.020	24.	60.	114.	91.4	136.4	86.	83.	1.58	1.357	MIX	.994-05
MMH	133	UNLIKE-DOUBLET	.024	.020	24.	60.	411.	125.8	179.6	83.	83.	1.66	1.238	UNDEF	.126-04
MMH	134	UNLIKE-DOUBLET	.024	.020	24.	60.	97.	92.8	136.3	77.	197.	1.74	1.216	M/S	.422-04
MMH	135	UNLIKE-DOUBLET	.024	.020	24.	60.	119.	93.9	139.2	78.	199.	1.72	1.237	M/S	.447-04
MMH	136	UNLIKE-DOUBLET	.024	.020	24.	60.	150.	92.4	136.5	77.	199.	1.74	1.227	SEP	.434-04
MMH	137	UNLIKE-DOUBLET	.024	.020	24.	60.	188.	97.7	143.8	76.	199.	1.74	1.218	SEP	.451-04
MMH	138	UNLIKE-DOUBLET	.024	.020	24.	60.	243.	93.3	148.9	79.	195.	1.60	1.438	SEP	.459-04
MMH	139	UNLIKE-DOUBLET	.024	.020	24.	60.	103.	35.8	58.4	61.	59.	1.45	1.615	UNDEF	.209-05
MMH	140	UNLIKE-DOUBLET	.024	.020	24.	60.	81.	97.4	143.0	64.	62.	1.61	1.306	UNDEF	.553-05

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR LAWVER

FUEL TYPE	TEST NO.	MODE	PC (PSIA)	VAVG	WEF	WEO	REF	REO	DELTI (DEG F)	RELF	RELO	PPF (PSIA)	PPO (PSIA)	MRVP	XF	XO	XP	RESID
MMH	101	SEP	308.	105.	43.7	36.0	.245+05	.651+05	0.	.59+06	.16+07	1.3	23.2	34.8	.00	.08	.18-01	.13-04
MMH	102	SEP	308.	105.	46.0	34.0	.252+05	.632+05	0.	.60+06	.15+07	1.3	23.2	34.8	.00	.08	.18-01	.13-04
MMH	103	SEP	309.	105.	44.4	35.2	.247+05	.643+05	0.	.59+06	.15+07	1.3	23.2	34.8	.00	.07	.18-01	.13-04
MMH	104	SEP	311.	104.	44.1	34.6	.245+05	.635+05	0.	.59+06	.15+07	1.3	23.2	34.8	.00	.07	.18-01	.13-04
MMH	105	SEP	507.	104.	68.3	59.6	.241+05	.655+05	0.	.58+06	.16+07	1.4	23.7	34.8	.00	.05	.11-01	.13-04
MMH	106	SEP	1000.	110.	163.5	121.4	.265+05	.666+05	0.	.64+06	.16+07	1.4	23.7	34.8	.00	.02	.57-02	.12-04
MMH	107	SEP	308.	103.	40.6	34.9	.233+05	.636+05	0.	.56+06	.15+07	1.3	22.1	34.8	.00	.07	.17-01	.13-04
MMH	108	SEP	263.	101.	34.6	27.5	.231+05	.607+05	0.	.55+06	.15+07	1.2	21.1	34.0	.00	.08	.19-01	.13-04
MMH	109	SEP	197.	111.	31.1	24.7	.253+05	.665+05	0.	.61+06	.16+07	1.2	21.1	34.0	.01	.11	.26-01	.12-04
MMH	110	SEP	158.	104.	22.4	17.0	.238+05	.613+05	0.	.57+06	.15+07	1.2	20.5	34.0	.01	.13	.32-01	.13-04
MMH	111	MIX	100.	109.	15.5	11.9	.249+05	.647+05	0.	.60+06	.16+07	1.2	21.1	34.8	.01	.21	.50-01	.12-04
A-50	112	MIX	89.	60.	4.7	3.1	.112+05	.342+05	0.	.27+06	.82+06	2.1	17.3	17.9	.02	.19	.68-01	.23-03
A-50	113	MIX	101.	105.	16.1	12.1	.211+05	.658+05	0.	.51+06	.16+07	2.8	23.2	17.9	.03	.23	.80-01	.13-04
A-50	114	MIX	162.	98.	21.6	16.3	.186+05	.591+05	0.	.45+06	.14+07	2.4	20.0	17.9	.02	.12	.43-01	.14-04
A-50	115	SEP	203.	104.	30.9	23.1	.193+05	.626+05	0.	.46+06	.15+07	2.2	19.5	19.2	.01	.10	.32-01	.13-04
A-50	116	SEP	269.	95.	33.8	25.6	.174+05	.571+05	0.	.42+06	.14+07	2.2	19.0	19.1	.01	.07	.24-01	.15-04
A-50	117	SEP	301.	71.	21.2	15.4	.129+05	.416+05	0.	.31+06	.10+07	2.1	18.1	18.7	.01	.06	.21-01	.19-04
A-50	118	SEP	310.	101.	45.7	32.0	.194+05	.597+05	0.	.47+06	.14+07	2.4	19.5	18.0	.01	.06	.22-01	.13-04
A-50	119	SEP	510.	99.	71.4	51.8	.190+05	.594+05	0.	.46+06	.14+07	2.4	20.0	17.9	.00	.04	.14-01	.14-04
A-50	120	SEP	1003.	101.	145.9	107.0	.193+05	.608+05	0.	.46+06	.15+07	2.4	20.0	18.4	.00	.02	.69-02	.14-04
A-50	121	MIX	160.	103.	24.2	17.4	.195+05	.612+05	0.	.47+06	.15+07	2.3	19.5	18.5	.01	.12	.42-01	.13-04
A-50	122	SEP	338.	83.	33.0	24.6	.157+05	.501+05	0.	.38+06	.12+07	2.3	19.5	18.5	.01	.06	.20-01	.17-04
A-50	123	SEP	334.	86.	35.1	25.6	.159+05	.507+05	0.	.38+06	.12+07	2.2	17.7	17.9	.01	.05	.19-01	.16-04
MMH	124	SEP	955.	62.	63.2	64.0	.185+05	.482+05	0.	.44+06	.12+07	1.2	20.0	33.9	.00	.02	.51-02	.16-04
MMH	125	SEP	495.	105.	70.8	54.0	.235+05	.618+05	0.	.56+06	.15+07	1.1	20.5	35.6	.00	.04	.98-02	.13-04
MMH	126	SEP	298.	105.	43.9	32.5	.241+05	.618+05	0.	.58+06	.15+07	1.2	20.5	34.8	.00	.07	.17-01	.13-04
MMH	127	M/S	283.	64.	15.5	11.4	.145+05	.376+05	0.	.35+06	.90+06	1.1	21.1	36.4	.00	.07	.17-01	.21-04
MMH	128	SEP	256.	101.	34.5	25.9	.232+05	.599+05	0.	.56+06	.14+07	1.2	21.6	35.6	.00	.08	.20-01	.13-04
MMH	129	SEP	191.	109.	29.7	22.5	.249+05	.647+05	0.	.60+06	.16+07	1.2	21.6	35.6	.01	.11	.27-01	.12-04
MMH	130	M/S	152.	103.	21.5	15.8	.236+05	.606+05	0.	.57+06	.15+07	1.2	21.6	36.4	.01	.14	.33-01	.13-04
MMH	131	MIX	95.	106.	14.2	10.5	.244+05	.627+05	0.	.59+06	.15+07	1.2	21.6	35.6	.01	.23	.54-01	.13-04
MMH	132	MIX	114.	109.	17.9	13.4	.251+05	.649+05	0.	.60+06	.16+07	1.2	22.1	36.4	.01	.19	.45-01	.12-04
MMH	133	UNDEF	411.	146.	112.1	90.4	.330+05	.877+05	0.	.79+06	.21+07	1.2	20.5	34.0	.00	.05	.12-01	.93-05
MMH	134	M/S	97.	139.	18.8	11.3	.558+05	.624+05	0.	.13+07	.15+07	17.9	17.7	2.4	.18	.18	.18+00	.12-04
MMH	135	M/S	119.	113.	24.1	14.2	.577+05	.635+05	0.	.14+07	.15+07	18.7	18.1	2.4	.16	.15	.15+00	.12-04
MMH	136	SEP	150.	109.	29.2	17.3	.566+05	.621+05	0.	.14+07	.15+07	18.7	17.7	2.3	.12	.12	.12+00	.12-04
MMH	137	SEP	148.	115.	30.7	24.0	.596+05	.653+05	0.	.14+07	.16+07	18.7	17.3	2.3	.10	.09	.96-01	.12-04
MMH	138	SEP	243.	115.	55.9	28.8	.601+05	.655+05	0.	.14+07	.15+07	17.2	18.6	2.6	.07	.08	.73-01	.11-04
MMH	139	UNDEF	103.	45.	2.9	1.6	.860+04	.220+05	0.	.21+06	.53+06	.6	12.0	41.2	.01	.12	.26-01	.29-04
MMH	140	UNDEF	81.	115.	13.5	9.7	.217+05	.608+05	0.	.52+06	.15+07	.6	12.9	41.2	.01	.16	.35-01	.12-04

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HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR LAWVER

FUEL TYPE	TEST NO.	INJECTOR TYPE	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	MODE	REACT (SEC)
MMH	141	UNLIKE-DOUBLET	,024	,020	24,	60,	81,	96,8	143,2	66,	64,	1,60	1,324	UNDEF	,582-05
MMH	142	UNLIKE-DOUBLET	,024	,020	24,	60,	119,	91,4	136,7	68,	67,	1,59	1,357	MIX	,604-05
MMH	143	UNLIKE-DOUBLET	,024	,020	24,	60,	129,	32,4	54,2	67,	67,	1,42	1,690	UNDEF	,237-05
MMH	144	UNLIKE-DOUBLET	,024	,020	24,	60,	154,	35,9	55,7	67,	67,	1,53	1,453	UNDEF	,243-05
MMH	145	UNLIKE-DOUBLET	,024	,020	24,	60,	152,	88,2	128,4	68,	67,	1,62	1,283	SEP	,567-05
MMH	146	UNLIKE-DOUBLET	,024	,020	24,	60,	190,	90,3	135,9	66,	67,	1,57	1,372	SEP	,600-05
MMH	147	UNLIKE-DOUBLET	,024	,020	24,	60,	258,	84,7	124,2	68,	67,	1,61	1,302	SEP	,548-05
MMH	148	UNLIKE-DOUBLET	,024	,020	24,	60,	102,	37,0	58,8	68,	68,	1,49	1,523	MIX	,265-05
MMH	149	UNLIKE-DOUBLET	,024	,020	24,	60,	99,	89,7	133,6	69,	69,	1,60	1,343	MIX	,622-05
MMH	150	UNLIKE-DOUBLET	,024	,020	24,	60,	297,	90,1	131,9	70,	69,	1,62	1,298	SEP	,621-05
MMH	151	UNLIKE-DOUBLET	,024	,020	24,	60,	464,	95,4	137,8	70,	69,	1,64	1,263	SEP	,648-05
MMH	152	UNLIKE-DOUBLET	,024	,020	24,	60,	958,	101,8	148,3	78,	74,	1,62	1,291	SEP	,850-05
MMH	153	UNLIKE-DOUBLET	,024	,020	24,	60,	98,	29,0	50,3	55,	56,	1,37	1,818	M/P	,158-05
MMH	154	UNLIKE-DOUBLET	,024	,020	24,	60,	100,	29,4	41,9	54,	55,	1,66	1,225	M/P	,127-05
MMH	155	UNLIKE-DOUBLET	,024	,020	24,	60,	102,	36,8	51,4	54,	54,	1,70	1,174	M/P	,153-05
MMH	156	UNLIKE-DOUBLET	,024	,020	24,	60,	107,	49,3	77,1	53,	54,	1,52	1,472	MIX	,226-05
MMH	157	UNLIKE-DOUBLET	,024	,020	24,	60,	102,	53,5	79,2	53,	54,	1,61	1,318	MIX	,233-05
MMH	158	UNLIKE-DOUBLET	,024	,020	24,	60,	101,	28,9	35,6	58,	58,	1,94	,918	M/P	,120-05
MMH	159	UNLIKE-DOUBLET	,024	,020	24,	60,	99,	30,3	43,0	57,	58,	1,68	1,211	M/P	,143-05
MMH	160	UNLIKE-DOUBLET	,024	,020	24,	60,	101,	39,2	56,6	57,	58,	1,65	1,258	M/P	,188-05
MMH	161	UNLIKE-DOUBLET	,024	,020	24,	60,	102,	37,8	58,2	57,	58,	1,54	1,429	M/P	,194-05
MMH	162	UNLIKE-DOUBLET	,024	,020	24,	60,	102,	41,4	54,0	57,	58,	1,82	[illegible]	M/P	,180-05
MMH	163	UNLIKE-DOUBLET	,024	,020	24,	60,	98,	58,5	85,1	57,	58,	1,63	[illegible]	MIX	,283-05
MMH	164	UNLIKE-DOUBLET	,024	,020	24,	60,	100,	50,1	72,1	56,	57,	1,65	1,249	MIX	,233-05
MMH	165	UNLIKE-DOUBLET	,024	,020	24,	60,	95,	72,3	106,7	56,	57,	1,61	1,313	MIX	,345-05
MMH	166	UNLIKE-DOUBLET	,024	,020	24,	60,	95,	92,1	134,3	56,	57,	1,63	1,282	MIX	,434-05
MMH	167	UNLIKE-DOUBLET	,024	,020	24,	60,	99,	51,2	74,1	55,	55,	1,63	1,262	MIX	,229-05
MMH	168	UNLIKE-DOUBLET	,024	,020	24,	60,	99,	51,6	74,7	55,	55,	1,63	1,267	MIX	,230-05
MMH	169	UNLIKE-DOUBLET	,024	,020	24,	60,	95,	52,6	75,1	44,	44,	1,66	1,223	UNDEF	,160-05
MMH	170	UNLIKE-DOUBLET	,024	,020	24,	60,	89,	112,4	164,1	44,	44,	1,62	1,281	MIX	,350-05
MMH	171	UNLIKE-DOUBLET	,024	,020	24,	60,	95,	111,0	161,0	44,	44,	1,63	1,265	MIX	,343-05
MMH	172	UNLIKE-DOUBLET	,024	,020	24,	60,	196,	44,8	57,5	44,	44,	1,84	,993	M/P	,123-05
MMH	173	UNLIKE-DOUBLET	,024	,020	24,	60,	198,	44,2	62,7	44,	44,	1,66	1,213	M/P	,134-05
MMH	174	UNLIKE-DOUBLET	,024	,020	24,	60,	201,	53,0	77,5	44,	44,	1,62	1,287	MIX	,165-05
MMH	175	UNLIKE-DOUBLET	,024	,020	24,	60,	192,	71,0	102,9	44,	44,	1,63	1,262	M/S	,219-05
MMH	176	UNLIKE-DOUBLET	,024	,020	24,	60,	97,	52,3	75,7	50,	50,	1,63	1,262	MIX	,197-05
MMH	177	UNLIKE-DOUBLET	,024	,020	24,	60,	97,	52,3	74,4	48,	48,	1,63	1,219	MIX	,162-05
MMH	178	UNLIKE-DOUBLET	,024	,020	24,	60,	97,	50,4	72,8	47,	48,	1,65	1,254	MIX	,176-05
MMH	179	UNLIKE-DOUBLET	,024	,020	24,	60,	97,	52,2	75,0	64,	68,	1,67	1,244	MIX	,323-05
MMH	180	UNLIKE-DOUBLET	,024	,020	24,	60,	202,	49,4	69,6	66,	71,	1,70	1,198	MIX	,326-05

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR LAWVER

FUEL (TYPE)	TEST NO.	MODE	PC (PSIA)	VAVG	WEF	WEO	REF	REO	DELTI (DEG F)	RELF	RELO	PPF (PSIA)	PPO (PSIA)	MRVP	XF	XO	XP	RESID
MMH	141	UNDEF	81.	115.	13.6	9.7	.221+05	.612+05	0.	.53+06	.15+07	.7	13.5	41.2	.01	.17	.37-01	.12-04
MMH	142	MIX	119.	109.	18.3	12.8	.218+05	.583+05	201.	.52+06	.14+07	.7	14.2	38.7	.01	.12	.27-01	.12-04
MMH	143	UNDEF	129.	41.	3.1	1.7	.863+04	.206+05	81.	.21+06	.49+06	.7	13.8	37.9	.01	.11	.25-01	.31-04
MMH	144	UNDEF	158.	44.	3.9	2.6	.887+04	.228+05	78.	.21+06	.55+06	.7	13.8	37.9	.00	.09	.21-01	.30-04
MMH	145	SEP	152.	104.	20.6	15.2	.204+05	.563+05	182.	.49+06	.14+07	.7	14.2	38.7	.00	.09	.21-01	.13-04
MMH	146	SEP	190.	108.	28.9	20.0	.216+05	.577+05	198.	.52+06	.14+07	.7	14.2	38.7	.00	.07	.17-01	.12-04
MMH	147	SEP	258.	100.	32.8	25.8	.198+05	.541+05	326.	.47+06	.13+07	.7	14.2	38.7	.00	.05	.12-01	.13-04
MMH	148	MIX	102.	46.	2.9	1.8	.944+04	.237+05	114.	.23+06	.57+06	.8	14.2	37.3	.01	.14	.32-01	.28-04
MMH	149	MIX	99.	107.	14.6	10.3	.217+05	.576+05	161.	.52+06	.14+07	.8	14.5	36.6	.01	.15	.34-01	.12-04
MMH	150	SEP	297.	106.	42.7	31.4	.214+05	.582+05	679.	.51+06	.14+07	.8	14.8	37.3	.00	.05	.12-01	.13-04
MMH	151	SEP	484.	111.	75.9	57.3	.223+05	.616+05	940.	.54+06	.15+07	.8	14.8	37.3	.00	.03	.71-02	.12-04
MMH	152	SEP	958.	120.	175.5	134.3	.252+05	.688+05	1342.	.60+06	.17+07	.9	18.1	38.3	.00	.02	.43-02	.11-04
MMH	153	M/P	98.	38.	2.0	1.0	.719+04	.173+05	115.	.17+06	.41+06	.5	10.1	38.0	.01	.10	.24-01	.33-04
MMH	154	M/P	100.	34.	1.4	1.0	.592+04	.174+05	158.	.14+06	.42+06	.5	9.8	37.9	.01	.10	.23-01	.40-04
MMH	155	M/P	102.	42.	2.2	1.7	.718+04	.218+05	170.	.17+06	.52+06	.5	9.8	39.0	.00	.10	.22-01	.32-04
MMH	156	MIX	107.	60.	5.1	3.1	.108+05	.291+05	86.	.26+06	.70+06	.5	9.5	37.8	.00	.09	.20-01	.22-04
MMH	157	MIX	102.	63.	5.2	3.5	.111+05	.316+05	86.	.27+06	.76+06	.5	9.5	37.8	.00	.09	.21-01	.21-04
MMH	158	M/P	101.	31.	1.0	1.0	.519+04	.175+05	171.	.12+06	.42+06	.6	11.0	39.2	.01	.11	.25-01	.47-04
MMH	159	M/P	99.	35.	1.5	1.1	.626+04	.183+05	136.	.15+06	.44+06	.6	10.7	38.2	.01	.11	.25-01	.39-04
MMH	160	M/P	101.	46.	2.6	1.9	.824+04	.236+05	145.	.20+06	.57+06	.6	10.7	38.2	.01	.11	.24-01	.29-04
MMH	161	M/P	102.	46.	2.8	1.8	.849+04	.228+05	131.	.20+06	.55+06	.6	10.7	38.2	.01	.11	.24-01	.29-04
MMH	162	M/P	102.	46.	2.4	2.1	.787+04	.249+05	145.	.19+06	.60+06	.6	10.7	38.2	.01	.11	.24-01	.31-04
MMH	163	MIX	98.	69.	5.8	4.1	.124+05	.352+05	94.	.30+06	.85+06	.6	10.7	38.2	.01	.11	.25-01	.20-04
MMH	164	MIX	100.	58.	4.2	3.0	.104+05	.300+05	85.	.25+06	.72+06	.5	10.4	38.1	.01	.10	.24-01	.23-04
MMH	165	MIX	95.	86.	8.8	6.0	.154+05	.434+05	72.	.37+06	.10+07	.5	10.4	30.1	.01	.11	.25-01	.16-04
MMH	166	MIX	95.	108.	13.9	9.8	.194+05	.552+05	79.	.46+06	.13+07	.5	10.4	38.1	.01	.11	.25-01	.12-04
MMH	167	MIX	99.	60.	4.9	3.1	.105+05	.306+05	65.	.25+06	.73+06	.5	10.1	39.1	.01	.10	.23-01	.22-04
MMH	168	MIX	99.	60.	4.5	3.2	.106+05	.307+05	65.	.25+06	.74+06	.5	10.1	39.1	.01	.10	.23-01	.22-04
MMH	169	UNDEF	95.	61.	4.3	3.0	.941+04	.308+05	75.	.23+06	.74+06	.4	7.4	42.2	.00	.08	.17-01	.22-04
MMH	170	MIX	89.	132.	19.0	13.0	.206+05	.658+05	102.	.49+06	.16+07	.4	7.4	42.2	.00	.08	.18-01	.10-04
MMH	171	MIX	95.	130.	19.6	13.5	.202+05	.649+05	106.	.48+06	.15+07	.4	7.4	42.2	.00	.08	.17-01	.10-04
MMH	172	M/P	196.	49.	5.2	4.5	.721+04	.262+05	76.	.17+06	.63+06	.4	7.4	42.2	.00	.04	.82-02	.29-04
MMH	173	M/P	196.	51.	6.2	4.5	.786+04	.258+05	67.	.19+06	.62+06	.4	7.4	42.2	.00	.04	.81-02	.27-04
MMH	174	MIX	201.	62.	9.6	6.5	.972+04	.310+05	71.	.23+06	.74+06	.4	7.4	42.2	.00	.04	.80-02	.21-04
MMH	175	M/S	192.	83.	16.1	11.2	.129+05	.415+05	116.	.31+06	.10+07	.4	7.4	42.2	.00	.04	.84-02	.16-04
MMH	176	MIX	97.	61.	4.5	3.1	.101+05	.304+05	83.	.24+06	.73+06	.4	8.6	38.7	.00	.09	.20-01	.22-04
MMH	177	MIX	97.	61.	4.3	3.1	.975+04	.305+05	82.	.23+06	.73+06	.4	8.2	39.7	.00	.08	.19-01	.22-04
MMH	178	MIX	97.	59.	4.1	2.9	.955+04	.294+05	69.	.23+06	.71+06	.4	8.0	38.9	.00	.08	.19-01	.23-04
MMH	179	MIX	97.	61.	4.5	3.3	.120+05	.326+05	68.	.29+06	.78+06	.8	12.9	34.2	.01	.13	.32-01	.22-04
MMH	180	MIX	202.	57.	6.1	6.3	.115+05	.312+05	110.	.28+06	.75+06	.8	13.5	32.2	.00	.07	.17-01	.24-04

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HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR LAWVER

FUEL TYPE	TEST NO.	INJECTOR TYPE	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	MODE	REACT (SEC)
MMH	181	UNLIKE-DOUBLET	.024	.020	24.	60.	295.	50.4	75.1	67.	73.	1.60	1.337	MIX	.370-05
MMH	182	UNLIKE-DOUBLET	.024	.020	24.	60.	182.	108.8	159.2	75.	78.	1.62	1.295	SEP	.941-05
MMH	183	UNLIKE-DOUBLET	.024	.020	24.	60.	198.	102.6	150.6	76.	77.	1.62	1.305	SEP	.887-05
MMH	184	UNLIKE-DOUBLET	.024	.020	24.	60.	259.	72.2	108.9	71.	70.	1.57	1.380	SEP	.530-05
MMH	185	UNLIKE-DOUBLET	.024	.020	24.	60.	269.	68.8	99.8	70.	70.	1.64	1.272	UNDEF	.479-05
MMH	186	UNLIKE-DOUBLET	.024	.020	24.	60.	262.	50.4	79.3	69.	70.	1.51	1.498	MIX	.377-05
MMH	187	UNLIKE-DOUBLET	.024	.020	24.	60.	293.	44.2	62.5	68.	69.	1.69	1.207	MIX	.288-05
MMH	188	UNLIKE-DOUBLET	.024	.020	24.	60.	300.	53.9	80.9	70.	70.	1.58	1.364	M/S	.389-05
MMH	189	UNLIKE-DOUBLET	.024	.020	24.	60.	295.	89.7	135.6	73.	72.	1.57	1.386	SEP	.705-05
MMH	190	UNLIKE-DOUBLET	.024	.020	24.	60.	99.	50.7	74.5	64.	82.	1.64	1.292	MIX	.409-05
MMH	191	UNLIKE-DOUBLET	.024	.020	24.	60.	98.	51.9	77.0	62.	93.	1.64	1.302	MIX	.487-05
MMH	192	UNLIKE-DOUBLET	.024	.020	24.	60.	98.	51.8	76.5	71.	109.	1.69	1.258	M/S	.121-04
MMH	193	UNLIKE-DOUBLET	.024	.020	24.	60.	99.	51.5	76.4	78.	177.	1.70	1.254	M/S	.188-04
MMH	194	UNLIKE-DOUBLET	.024	.020	24.	60.	99.	53.0	78.5	80.	200.	1.73	1.236	M/S	.261-04
MMH	195	UNLIKE-DOUBLET	.024	.020	24.	60.	202.	49.9	71.8	82.	196.	1.77	1.173	SEP	.233-04
MMH	196	UNLIKE-DOUBLET	.024	.020	24.	60.	202.	49.6	70.9	124.	178.	1.69	1.214	SEP	.302-04
MMH	197	UNLIKE-DOUBLET	.024	.020	24.	60.	202.	49.3	67.7	112.	89.	1.69	1.169	MIX	.723-05
A-50	198	UNLIKE-DOUBLET	.024	.020	24.	60.	92.	36.6	51.6	53.	60.	1.64	1.234	M/P	.300-05
A-50	199	UNLIKE-DOUBLET	.024	.020	24.	60.	94.	45.4	66.5	74.	85.	1.58	1.337	UNDEF	.712-05
A-50	200	UNLIKE-DOUBLET	.024	.020	24.	60.	89.	50.3	72.7	65.	75.	1.60	1.297	MIX	.609-05
A-50	201	UNLIKE-DOUBLET	.024	.020	24.	60.	97.	52.5	76.5	68.	73.	1.59	1.319	MIX	.647-05
A-50	202	UNLIKE-DOUBLET	.024	.020	24.	60.	81.	79.8	114.2	69.	74.	1.61	1.277	MIX	.989-05
A-50	203	UNLIKE-DOUBLET	.024	.020	24.	60.	102.	90.3	127.2	72.	72.	1.63	1.241	MIX	.112-04
A-50	204	UNLIKE-DOUBLET	.024	.020	24.	60.	95.	111.3	157.2	70.	70.	1.63	1.246	MIX	.131-04
A-50	205	UNLIKE-DOUBLET	.024	.020	24.	60.	201.	41.2	49.7	66.	68.	1.91	.907	M/P	.386-05
A-50	206	UNLIKE-DOUBLET	.024	.020	24.	60.	199.	51.5	70.6	77.	69.	1.67	1.179	MIX	.635-05
A-50	207	UNLIKE-DOUBLET	.024	.020	24.	60.	193.	114.1	162.0	80.	81.	1.61	1.266	SEP	.175-04
A-50	208	UNLIKE-DOUBLET	.024	.020	24.	60.	295.	44.9	64.6	70.	74.	1.60	1.293	MIX	.565-05
A-50	209	UNLIKE-DOUBLET	.024	.020	24.	60.	291.	43.6	64.1	63.	63.	1.57	1.351	MIX	.449-05
A-50	210	UNLIKE-DOUBLET	.024	.020	24.	60.	293.	42.1	60.0	61.	[illegible]	1.62	1.265	MIX	.415-05
A-50	211	UNLIKE-DOUBLET	.024	.020	24.	60.	290.	42.8	67.5	62.	68.	1.47	1.542	UNDEF	.499-05
A-50	212	UNLIKE-DOUBLET	.024	.020	24.	60.	290.	53.7	76.5	78.	84.	1.61	1.269	UNDEF	.848-05
A-50	213	UNLIKE-DOUBLET	.024	.020	24.	60.	289.	74.2	106.3	76.	79.	1.60	1.282	UNDEF	.107-04
A-50	214	UNLIKE-DOUBLET	.024	.020	24.	60.	293.	90.8	130.7	75.	77.	1.60	1.295	UNDEF	.127-04
A-50	215	UNLIKE-DOUBLET	.024	.020	24.	60.	292.	112.8	163.2	71.	75.	1.59	1.306	UNDEF	.147-04
A-50	216	UNLIKE-DOUBLET	.024	.020	24.	60.	489.	72.3	104.2	68.	70.	1.60	1.296	SEP	.849-05
A-50	217	UNLIKE-DOUBLET	.024	.020	24.	60.	491.	92.8	133.4	68.	68.	1.60	1.292	SEP	.106-04
MMH	218	XDT1	.024	.021	0.	0.	135.	44.0	56.8	65.	70.	1.67	1.005	MIX	.284-05
MMH	219	XDT1	.024	.021	0.	0.	124.	50.3	63.5	72.	73.	1.70	.967	MIX	.366-05
MMH	220	XDT1	.024	.021	0.	0.	98.	39.9	52.6	69.	71.	1.63	1.052	MIX	.281-05

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR LAWVER

FUEL TYPE	TEST NO.	MODE	PC (PSIA)	VAVG	WEF	WEO	REF	REO	DELTI (DEG F)	RELF	RELO	PPF (PSIA)	PPO (PSIA)	MRVP	XF	YO	XP	RESID
MMH	181	MIX	295.	60.	13.8	9.6	.126+05	.320+05	128.	.30+06	.77+06	.9	13.8	30.8	.00	.05	.12-01	.22-04
MMH	182	SEP	182.	128.	38.7	28.7	.280+05	.723+05	129.	.67+06	.17+07	1.1	16.9	32.0	.01	.09	.23-01	.10-04
MMH	183	SEP	198.	121.	37.6	27.9	.263+05	.686+05	129.	.63+06	.16+07	1.0	17.3	33.7	.01	.09	.21-01	.11-04
MMH	184	SEP	259.	86.	25.4	17.6	.178+05	.469+05	141.	.43+06	.11+07	.8	15.2	37.0	.00	.06	.14-01	.15-04
MMH	185	UNDEF	269.	81.	22.2	16.6	.163+05	.444+05	141.	.39+06	.11+07	.8	14.8	36.0	.00	.05	.13-01	.17-04
MMH	186	MIX	262.	62.	13.7	8.6	.130+05	.324+05	101.	.31+06	.78+06	.8	14.5	35.4	.00	.06	.13-01	.21-04
MMH	187	MIX	293.	51.	9.5	7.4	.101+05	.282+05	95.	.24+06	.60+06	.8	14.2	35.9	.00	.05	.1-01	.27-04
MMH	188	M/S	300.	64.	16.3	11.3	.132+05	.348+05	108.	.32+06	.84+06	.8	14.8	36.0	.00	.05	.12-01	.21-04
MMH	189	SEP	295.	108.	45.0	31.3	.226+05	.589+05	140.	.54+06	.14+07	.9	16.0	36.4	.00	.05	.13-01	.12-04
MMH	190	MIX	99.	60.	4.6	3.2	.136+05	.317+05	61.	.33+06	.76+06	1.2	12.9	22.6	.01	.13	.39-01	.22-04
MMH	191	MIX	98.	61.	5.0	3.3	.154+05	.321+05	49.	.37+06	.77+06	1.6	12.3	16.4	.02	.13	.45-01	.22-04
MMH	192	M/S	96.	61.	5.4	3.4	.229+05	.336+05	40.	.55+06	.81+06	6.5	15.2	5.3	.07	.16	.10+00	.22-04
MMH	193	M/S	99.	61.	5.8	3.6	.275+05	.348+05	27.	.66+06	.84+06	12.0	18.1	3.6	.12	.18	.15+00	.22-04
MMH	194	M/S	99.	62.	6.4	3.8	.327+05	.363+05	18.	.79+06	.87+06	19.1	19.0	2.4	.19	.19	.19+00	.21-04
MMH	195	SEP	202.	58.	10.8	7.0	.292+05	.346+05	54.	.70+06	.83+06	17.6	20.0	2.8	.09	.10	.93-01	.23-04
MMH	196	SEP	202.	58.	10.2	8.8	.257+05	.437+05	69.	.62+06	.10+07	12.2	52.9	9.5	.06	.26	.13+00	.23-04
MMH	197	MIX	202.	56.	7.9	8.0	.131+05	.408+05	115.	.31+06	.98+06	1.4	40.5	56.0	.01	.20	.37-01	.25-04
A-50	198	M/P	92.	42.	2.3	1.5	.695+04	.216+05	111.	.17+06	.52+06	1.4	9.5	15.1	.02	.10	.40-01	.32-04
A-50	199	UNDEF	94.	54.	4.0	2.6	.108+05	.300+05	89.	.26+06	.72+06	2.7	16.5	13.8	.03	.18	.71-01	.25-04
A-50	200	MIX	89.	59.	4.5	2.9	.109+05	.316+05	109.	.26+06	.76+06	2.1	13.2	14.2	.02	.15	.59-01	.23-04
A-50	201	MIX	97.	62.	5.4	3.5	.113+05	.336+05	143.	.27+06	.81+06	2.0	14.2	15.8	.02	.15	.55-01	.22-04
A-50	202	MIX	81.	93.	10.1	6.7	.170+05	.512+05	145.	.41+06	.12+07	2.0	14.5	15.8	.03	.18	.67-01	.15-04
A-50	203	MIX	102.	104.	15.8	10.9	.186+05	.589+05	149.	.45+06	.14+07	1.9	15.6	17.6	.02	.15	.54-01	.13-04
A-50	204	MIX	95.	129.	22.4	15.3	.227+05	.719+05	155.	.54+06	.17+07	1.9	14.8	17.5	.02	.16	.55-01	.11-04
A-50	205	M/P	201.	49.	4.7	4.4	.707+04	.260+05	172.	.17+06	.62+06	1.3	13.5	16.9	.01	.07	.24-01	.34-04
A-50	206	MIX	199.	59.	9.5	7.1	.101+05	.347+05	183.	.24+06	.83+06	1.8	17.7	21.2	.01	.09	.28-01	.24-04
A-50	207	SEP	193.	132.	48.9	34.4	.254+05	.781+05	202.	.61+06	.19+07	2.4	19.0	17.5	.01	.10	.35-01	.10-04
A-50	208	MIX	295.	52.	11.8	7.7	.960+04	.290+05	202.	.23+06	.70+06	2.0	14.8	16.1	.01	.05	.19-01	.26-04
A-50	209	MIX	291.	52.	11.4	6.9	.881+04	.271+05	202.	.21+06	.65+06	1.5	12.6	18.0	.01	.04	.15-01	.26-04
A-50	210	MIX	293.	49.	10.1	6.5	.830+04	.259+05	202.	.20+06	.62+06	1.6	12.0	16.7	.01	.04	.15-01	.28-04
A-50	211	UNDEF	290.	53.	12.6	6.7	.960+04	.265+05	272.	.23+06	.64+06	1.8	12.3	15.5	.01	.04	.16-01	.25-04
A-50	212	UNDEF	290.	62.	16.4	11.3	.123+05	.363+05	391.	.30+06	.87+06	2.6	18.1	15.5	.01	.06	.24-01	.22-04
A-50	213	UNDEF	289.	87.	31.4	21.3	.164+05	.496+05	282.	.39+06	.12+07	2.3	17.3	16.9	.01	.06	.22-01	.16-04
A-50	214	UNDEF	293.	106.	48.1	32.3	.199+05	.604+05	332.	.48+06	.14+07	2.2	16.9	17.1	.01	.06	.21-01	.13-04
A-50	215	UNDEF	292.	132.	74.6	48.6	.244+05	.733+05	379.	.59+06	.18+07	2.1	15.2	16.2	.01	.05	.19-01	.10-04
A-50	216	SEP	439.	85.	50.7	32.9	.150+05	.462+05	803.	.36+06	.11+07	1.9	14.2	16.8	.00	.03	.10-01	.16-04
A-50	217	SEP	431.	108.	83.5	54.4	.190+05	.542+05	762.	.46+06	.14+07	1.8	14.2	17.6	.00	.03	.10-01	.12-04
MMH	218	MIX	[illegible]	49.	3.8	3.3	.976+04	.276+05	214.	.98+03	.28+04	.8	13.2	32.0	.01	.10	.24-01	.31-04
MMH	219	MIX	124.	55.	4.4	4.1	.112+05	.328+05	209.	.11+04	.33+04	.9	15.6	34.4	.01	.13	.30-01	.28-04
MMH	220	MIX	96.	45.	2.4	2.0	.913+04	.256+05	183.	.91+03	.26+04	.8	14.5	34.2	.01	.15	.36-01	.35-04

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HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR LAWVER

FUEL TYPE	TEST NO.	INJECTOR TYPE	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	MODE	REACT (SEC)
MMH	221	XDT1	.024	.021	0.	0.	81.	32.6	42.6	62.	68.	1.66	1.029	MIX	.197-05
MMH	222	XDT1	.024	.021	0.	0.	148.	59.7	76.1	76.	75.	1.69	.986	SEP	.478-05
MMH	223	XDT1	.024	.021	0.	0.	194.	79.1	100.7	79.	97.	1.71	.975	SEP	.928-05
MMH	224	XDT1	.024	.021	0.	0.	122.	50.6	63.8	[illegible]	141.	1.77	.930	MIX	.106-04
MMH	225	XDT1	.024	.021	0.	0.	123.	51.3	64.4	80.	164.	1.80	.909	MIX	.150-0[illegible]
MMH	226	XDT1	.024	.021	0.	0.	122.	51.2	66.0	93.	229.	1.82	.925	SEP	[illegible]
MMH	227	XDT1	.024	.021	0.	0.	122.	51.9	66.7	116.	242.	1.81	.929	SEP	.570-04
MMH	228	XDT	.024	.021	0.	0.	144.	61.3	78.7	127.	249.	1.80	.928	SEP	[illegible]
MMH	229	XDT1	.024	.021	0.	0.	119.	53.0	71.1	109.	245.	1.75	1.001	SEP	.582-04
MMH	230	XDT1	.024	.021	0.	0.	122.	52.1	70.5	120.	268.	1.75	1.011	SEP	.826-04
MMH	231	XDT1	.024	.021	0.	0.	146.	62.2	83.5	136.	280.	1.76	.999	SEP	.129-03
MMH	232	XDT1	.024	.021	0.	0.	145.	63.7	86.0	162.	291.	1.72	1.022	SEP	.190-03
MMH	233	XDT1	.024	.021	0.	0.	124.	53.3	73.3	153.	285.	1.69	1.060	SEP	.141-03
MMH	234	SPLASH PLATE	.024	.021	0.	90.	123.	[illegible]	62.7	73.	76.	1.68	.996	M/S	.386-05
MMH	236	SPLASH PLATE	.024	.021	0.	90.	102.	37.8	48.2	71.	72.	1.69	.983	M/S	.269-05
MMH	237	SPLASH PLATE	.024	.021	0.	90.	81.	31.8	40.8	74.	76.	1.68	.997	MIX	.254-05
MMH	238	SPLASH PLATE	.024	.021	0.	90.	144.	59.8	76.8	78.	82.	1.68	.999	SEP	.551-05
MMH	239	SPLASH PLATE	.024	.021	0.	90.	186.	80.1	104.2	79.	79.	1.65	1.027	SEP	.724-05
MMH	240	SPLASH PLATE	.024	.021	0.	90.	164.	53.2	70.1	74.	74.	1.64	1.052	SEP	.422-05
MMH	241	SPLASH PLATE	.024	.021	0.	90.	160.	55.5	71.9	77.	79.	1.66	1.018	SEP	.488-05
MMH	242	SPLASH PLATE	.024	.021	0.	90.	166.	53.4	68.4	78.	71.	1.67	1.001	SEP	.409-05
MMH	243	SPLASH PLATE	.024	.021	0.	90.	192.	79.0	103.2	78.	75.	1.64	1.038	SEP	.664-05
MMH	244	SPLASH PLATE	.024	.021	0.	90.	123.	49.9	66.3	79.	170.	1.72	1.015	SEP	.166-04
MMH	245	SPLASH PLATE	.024	.021	0.	90.	117.	51.6	71.5	85.	239.	1.72	1.054	SEP	.412-04
MMH	246	SPLASH PLATE	.024	.021	0.	90.	119.	52.4	73.1	136.	288.	1.70	1.069	SEP	.121-03
MMH	247	SPLASH PLATE	.024	.021	0.	90.	139.	63.1	88.6	132.	283.	1.69	1.086	SEP	.135-03
MMH	248	SPLASH PLATE	.024	.021	0.	90.	137.	64.7	89.0	153.	288.	1.69	1.058	SEP	.175-03
MMH	249	SPLASH PLATE	.024	.021	0.	90.	147.	61.4	84.8	154.	287.	1.69	1.068	SEP	.167-03
MMH	250	TRIPLET	.050	.029	4.	32.	129.	48.1	103.8	73.	75.	2.15	2.816	M/S	.124-04
MMH	251	TRIPLET	.050	.029	4.	32.	125.	49.7	97.6	70.	75.	2.37	2.332	M/S	.112-04
MMH	252	TRIPLET	.050	.029	4.	32.	99.	38.5	77.2	68.	78.	2.33	2.424	MIX	.910-05
MMH	253	TRIPLET	.050	.029	4.	32.	80.	31.7	61.3	72.	78.	[illegible]	2.259	MIX	.759-05
MMH	254	TRIPLET	.050	.029	4.	32.	146.	58.1	126.8	72.	76.	2.13	2.879	MIX	.152-04
MMH	255	TRIPLET	.050	.029	4.	32.	194.	76.6	155.6	71.	69.	2.28	2.503	SEP	.162-04
MMH	256	TRIPLET	.050	.029	4.	32.	119.	52.1	115.2	77.	178.	2.23	2.789	MIX	.616-03
MMH	257	TRIPLET	.050	.029	4.	32.	116.	53.8	122.9	76.	244.	2.27	2.828	M/S	.133-03
MMH	258	TRIPLET	.050	.029	4.	32.	113.	56.7	155.1	140.	312.	1.90	4.039	SEP	.561-03
MMH	259	TRIPLET	.050	.029	4.	32.	131.	65.3	149.1	120.	300.	2.31	2.796	SEP	.459-03
MMH	260	TRIPLET	.050	.029	4.	32.	137.	64.4	142.4	153.	301.	2.30	2.697	SEP	.625-03
MMH	275	SMALL TRIPLET	.034	.020	4.	32.	126.	50.4	134.6	59.	71.	1.76	4.279	M/P	.578-05

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR LAWVER

FUEL TYPE	TEST NO.	MODE	PC (PSIA)	VAVG	WEF	WEO	REF	REO	DELTI (DEG F)	RELF	RELU	PPF (PSIA)	PPO (PSIA)	MRVP	XF	XO	XP	RESID
MMH	221	MIX	81.	35.	1.3	1.1	.718+04	.202+05	165.	.72+03	.20+04	.8	12.3	32.7	.02	.15	.38-01	.41-04
MMH	222	SEP	148.	66.	7.5	7.1	.137+05	.399+05	229.	.14+04	.40+04	1.0	17.3	35.6	.01	.12	.28-01	.23-04
MMH	223	SEP	194.	87.	17.9	16.5	.218+05	.538+05	223.	.22+04	.54+04	1.8	18.6	21.2	.01	.10	.30-01	.17-04
MMH	224	MIX	122.	55.	4.9	4.2	.190+05	.340+05	158.	.19+04	.34+04	5.3	17.7	7.5	.04	.15	.79-01	.27-04
MMH	225	MIX	123.	56.	5.2	4.4	.224+05	.351+05	137.	.22+04	.35+04	8.8	19.0	5.0	.07	.15	.11+00	.27-04
MMH	226	SEP	122.	56.	6.2	4.7	.345+05	.380+05	82.	.34+04	.38+04	30.9	26.2	2.1	.25	.21	.23+00	.27-04
MMH	227	SEP	122.	57.	6.5	5.5	.377+05	.438+05	82.	.38+04	.44+04	37.0	44.4	2.9	.30	.36	.33+00	.26-04
MMH	228	SEP	144.	68.	10.9	9.7	.454+05	.548+05	82.	.45+04	.55+04	42.3	56.5	3.2	.29	.39	.34+00	.22-04
MMH	229	SEP	119.	60.	7.3	5.4	.409+05	.432+05	73.	.41+04	.43+04	39.3	37.8	2.4	.33	.32	.32+00	.25-04
MMH	230	SEP	122.	59.	7.8	5.7	.467+05	.448+05	42.	.47+04	.45+04	56.8	48.2	2.1	.47	.40	.43+00	.25-04
MMH	231	SEP	146.	70.	13.4	10.8	.594+05	.580+05	46.	.59+04	.59+04	65.9	69.5	2.6	.45	.47	.46+00	.21-04
MMH	232	SEP	145.	72.	14.5	13.7	.654+05	.704+05	40.	.65+04	.70+04	74.7	116.0	3.7	.52	.80	.64+00	.20-04
MMH	233	SEP	124.	61.	8.9	7.6	.538+05	.555+05	30.	.54+04	.56+04	69.7	97.1	3.4	.56	.78	.66+00	.24-04
MMH	234	M/S	123.	54.	4.2	3.9	.114+05	.321+05	195.	.11+04	.32+04	1.0	16.0	32.3	.01	.13	.33-01	.28-04
MMH	236	M/S	102.	42.	2.1	1.9	.844+04	.240+05	196.	.84+03	.25+04	.9	15.2	34.6	.01	.15	.36-01	.36-04
MMH	237	MIX	81.	35.	1.2	1.1	.740+04	.210+05	178.	.74+03	.21+04	1.0	16.5	35.0	.01	.20	.50-01	.43-04
MMH	238	SEP	144.	66.	7.5	7.0	.147+05	.404+05	178.	.15+04	.40+04	1.2	18.1	31.0	.01	.13	.32-01	.27-04
MMH	239	SEP	166.	89.	17.6	16.3	.194+05	.545+05	178.	.19+04	.55+04	1.1	18.6	34.1	.01	.10	.24-01	.17-04
MMH	240	SEP	164.	60.	7.0	6.2	.123+05	.351+05	89.	.12+04	.35+04	.9	16.5	35.0	.01	.10	.24-01	.25-04
MMH	241	SEP	160.	52.	7.3	6.6	.134+05	.373+05	182.	.13+04	.37+04	1.1	17.7	[illegible]	.01	.11	.27-01	.24-04
MMH	242	SEP	166.	59.	6.8	6.4	.119+05	.361+05	189.	.12+04	.36+04	.8	18.1	42.1	.01	.11	.24-01	.26-04
MMH	243	SEP	192.	68.	17.9	16.2	.186+05	.534+05	234.	.19+04	.53+04	1.0	18.1	37.2	.01	.09	.22-01	.17-04
MMH	244	SEP	123.	56.	5.6	4.2	.240+05	.339+05	113.	.24+04	.34+04	10.2	18.6	4.2	.08	.15	.11+00	.26-04
MMH	245	SEP	117.	59.	7.2	4.4	.397+05	.364+05	65.	.40+04	.35+04	35.1	21.6	1.6	.30	.16	.24+00	.24-04
MMH	246	SEP	119.	60.	8.5	6.5	.54[illegible]+05	.494+05	23.	.55+04	.49+04	72.0	68.5	2.4	.60	.58	.59+00	.24-04
MMH	[illegible]	SEP	159.	73.	14.5	10.5	.642+05	.581+05	44.	.64+04	.58+04	68.2	62.8	2.3	.49	.45	.47+00	.20-04
MMH	[illegible]	SEP	137.	74.	14.0	12.4	.665+05	.677+05	45.	.66+04	.66+04	72.0	97.1	3.3	.53	.71	.61+00	.20-04
MMH	[illegible]	SEP	147.	70.	[illegible]	12.0	.629+05	.646+05	44.	.63+04	.65+04	71.2	99.1	3.4	.48	.67	.57+00	.21-04
MMH	25[illegible]	M/S	129.	66.	17.1	8.1	.262+05	.652+05	44.	.10+06	.26+06	1.0	16.0	33.2	.01	.12	.31-01	.24-04
MMH	251	M/S	125.	64.	[illegible]	[illegible]	.247+05	.662+05	44.	.99+05	.25+06	1.0	14.8	30.8	.01	.12	.30-01	.25-04
[illegible]	[illegible]	MIX	[illegible]	[illegible]	7.3	[illegible]	.209+05	[illegible]	44.	.80+05	.20+06	1.1	14.2	27.2	.01	.14	.39-01	.32-04
[illegible]	[illegible]	MIX	[illegible]	[illegible]	[illegible]	2.2	.159+05	.427+05	44.	.64+05	.17+06	1.1	15.6	29.8	.01	.20	.51-01	.40-04
[illegible]	[illegible]	MIX	146.	[illegible]	24.9	13.3	.323+05	.782+05	44.	.13+06	.31+06	1.0	15.6	31.5	.01	.11	.27-01	.19-04
[illegible]	[illegible]	[illegible]	194.	[illegible]	57.2	33.7	.372+05	.103+06	44.	.15+06	.41+06	.8	15.2	34.3	[illegible]	.05	.18-01	[illegible]
[illegible]	[illegible]	[illegible]	119.	72.	23.3	9.0	.616+05	.722+05	[illegible]	.25+06	.29+06	12.2	17	3.4	.10	.15	.12+00	.21-04
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.?00+05	.741+05	[illegible]	.40+06	.30+06	38.5	[illegible]	1.2	.33	.15	.22+00	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14.7	.156+06	.113+06	44.	.75+06	.45+06	100.6	74.1	1.9	.89	.60	.76+00	.16-04
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.165+06	.116+06	44.	.67+06	.46+06	85.8	48.2	1.5	.65	.37	.49+00	.16-04
[illegible]	[illegible]	SEP	[illegible]	[illegible]	54.2	25.[illegible]	.162+06	.137+06	44.	.65+06	.56+06	87.0	97.1	2.8	.64	.71	.67+00	.17-04
[illegible]	[illegible]	[illegible]	[illegible]	51.	[illegible]	5.5	.222+05	.424+05	44.	.89+05	.17+06	.6	11.4	27.5	.01	.09	.25-01	.12-04

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OF POOR QUALITY

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR LAWVER

FUEL TYPE	TEST NO.	INJECTOR TYPE	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	MODE	REACT (SEC)
MMH	276	SMALL TRIPLET	.034	.020	4.	32.	129.	47.0	131.7	78.	77.	1.66	4.760	MIX	.794-05
MMH	277	SMALL TRIPLET	.034	.020	4.	32.	101.	36.1	100.6	71.	80.	1.67	4.682	MIX	.582-05
MMH	278	SMALL TRIPLET	.034	.020	4.	32.	81.	30.5	77.4	71.	77.	1.64	3.887	MIX	.427-05
MMH	279	SMALL TRIPLET	.034	.020	4.	32.	157.	54.1	155.1	71.	75.	1.63	4.960	M/S	.828-05
MMH	280	SMALL TRIPLET	.034	.020	4.	32.	210.	72.2	205.4	72.	73.	1.64	4.896	SEP	.107-04
MMH	281	SMALL TRIPLET	.034	.020	4.	32.	129.	48.4	142.9	80.	150.	1.64	5.079	MIX	.255-04
MMH	282	SMALL TRIPLET	.034	.020	4.	32.	129.	48.8	148.9	85.	226.	1.66	5.163	MIX	.695-04
MMH	283	SMALL TRIPLET	.034	.020	4.	32.	132.	47.3	146.2	85.	250.	1.68	5.188	MIX	.868-04
MMH	284	SMALL TRIPLET	.034	.020	4.	32.	130.	49.3	152.0	130.	287.	1.66	5.213	M/S	.211-03
MMH	285	SMALL TRIPLET	.034	.020	4.	32.	156.	58.6	181.9	131.	296.	1.67	5.232	SEP	.279-03
MMH	286	SMALL TRIPLET	.034	.020	4.	32.	150.	61.3	190.0	145.	297.	1.66	5.280	SEP	.341-03
MMH	287	UNLIKE-DOUBLET	.024	.020	24.	60.	124.	49.2	72.5	72.	82.	1.63	1.[illegible]09	MIX	.039-05
MMH	288	UNLIKE-DOUBLET	.024	.020	24.	60.	98.	39.3	57.6	73.	72.	1.62	1.299	M/P	.299-05
MMH	289	UNLIKE-DOUBLET	.024	.020	24.	60.	78.	32.5	50.1	75.	76.	1.54	1.439	M/P	.287-05
MMH	290	UNLIKE-DOUBLET	.024	.020	24.	60.	78.	33.2	48.[illegible]	74.	75.	1.62	1.294	M/P	.270-05
MMH	291	UNLIKE-DOUBLET	.024	.020	24.	60.	147.	58.9	84.3	75.	75.	1.66	1.[illegible]41	MIX	.474-05
MMH	292	UNLIKE-DOUBLET	.024	.020	24.	60.	198.	78.9	113.9	76.	76.	1.65	1.265	M/S	.660-05
MMH	293	UNLIKE-DOUBLET	.024	.020	24.	60.	123.	50.7	76.7	75.	185.	1.68	1.293	SEP	.199-04
MMH	294	UNLIKE-DOUBLET	.024	.020	24.	60.	123.	51.0	78.5	80.	249.	1.74	1.282	SEP	.432-04
MMH	295	UNLIKE-DOUBLET	.024	.020	24.	60.	121.	53.0	82.4	116.	240.	1.65	1.360	SEP	.622-04
MMH	296	UNLIKE-DOUBLET	.024	.020	24.	60.	145.	64.5	99.4	131.	290.	1.71	1.296	SEP	.143-03
MMH	297	UNLIKE-DOUBLET	.024	.020	24.	60.	144.	66.6	104.6	152.	294.	1.65	1.371	SEP	.195-03

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR LAWVER

FUEL TYPE	TEST NO.	MODE	PC (PSIA)	VAVG	WEF	WEO	REF	REO	DELTI (DEG F)	RELF	RELO	PPF (PSIA)	PPO (PSIA)	MRVP	XF	XO	XP	RESID
MMH	276	MIX	129.	79.	18.7	5.4	.230+05	.445+05	44.	.92+05	.18+06	1.0	18.1	35.2	.01	.14	.34-01	.13-04
MMH	277	MIX	101.	60.	8.6	2.4	.180+05	.328+05	44.	.72+05	.13+06	1.1	15.2	27.6	.01	.15	.41-01	.17-04
MMH	278	MIX	81.	47.	4.1	1.4	.135+05	.277+05	44.	.54+05	.11+06	1.0	15.2	29.8	.01	.19	.49-01	.22-04
MMH	279	M/S	157.	93.	31.5	8.4	.266+05	.492+05	44.	.11+06	.20+06	1.0	15.2	31.6	.01	.10	.24-01	.11-04
MMH	280	SEP	210.	123.	73.7	20.2	.346+05	.660+05	44.	.14+06	.26+06	.9	15.6	34.4	.00	.07	.18-01	.81-05
MMH	281	MIX	129.	84.	25.1	5.8	.432+05	.463+05	44.	.17+06	.19+06	6.7	19.0	6.4	.05	.15	.87-01	.12-04
MMH	282	MIX	129.	86.	31.7	6.0	.727+05	.482+05	44.	.29+06	.19+06	29.6	21.6	1.8	.23	.17	.20+00	.11-04
MMH	283	MIX	132.	64.	33.0	5.8	.626+05	.467+05	44.	.33+06	.19+06	43.1	21.6	1.3	.33	.16	.23+00	.11-04
MMH	284	M/S	130.	88.	38.3	8.1	.107+06	.627+05	44.	.43+06	.25+06	71.2	60.0	2.1	.55	.46	.50+00	.11-04
MMH	285	SEP	156.	105.	67.4	13.9	.136+06	.751+05	44.	.54+06	.30+06	80.9	61.4	1.9	.52	.39	.45+00	.92-05
MMH	286	SEP	150.	110.	70.8	16.1	.143+06	.855+05	44.	.57+06	.34+06	82.1	82.6	2.5	.55	.55	.55+00	.88-05
MMH	287	MIX	124.	58.	5.5	3.9	.132+05	.321+05	44.	.32+06	.77+06	1.2	15.6	27.0	.01	.13	.35-01	.23-04
MMH	288	M/P	98.	46.	2.7	2.0	.960+04	.258+05	44.	.23+06	.62+06	.9	16.0	36.4	.01	.16	.38-01	.29-04
MMH	289	M/P	78.	39.	1.6	1.1	.866+04	.216+05	44.	.21+06	.52+06	1.0	16.9	33.8	.01	.22	.53-01	.33-04
MMH	290	M/P	78.	39.	1.5	1.1	.832+04	.219+05	44.	.20+06	.53+06	1.0	16.5	34.0	.01	.21	.51-01	.34-04
MMH	291	MIX	147.	68.	8.7	6.8	.144+05	.391+05	44.	.35+06	.94+06	1.0	16.9	34.8	.01	.11	.28-01	.20-04
MMH	292	M/S	198.	92.	21.5	16.5	.197+05	.527+05	44.	.47+06	.13+07	1.0	17.3	34.6	.01	.09	.21-01	.15-04
MMH	293	SEP	123.	60.	7.4	4.2	.291+05	.337+05	44.	.70+06	.81+06	14.0	16.9	2.9	.11	.14	.12+00	.22-04
MMH	294	SEP	123.	61.	8.6	4.4	.441+05	.349+05	44.	.11+07	.84+06	42.3	19.0	1.2	.34	.15	.23+00	.21-04
MMH	295	SEP	121.	64.	9.4	5.7	.438+05	.447+05	44.	.11+07	.11+07	35.5	44.4	3.0	.29	.37	.33+00	.20-04
MMH	296	SEP	145.	77.	18.4	11.2	.716+05	.590+05	44.	.17+07	.14+07	73.5	61.4	2.1	.51	.42	.46+00	.17-04
MMH	297	SEP	144.	81.	20.5	13.7	.772+05	.693+05	44.	.19+07	.17+07	78.4	95.1	3.0	.54	.66	.60+00	.16-04

ZETA PLOT FILE HAS BEEN CREATED... 4608 CHARACTERS

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HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR RCKTD

FUEL TYPE	TEST NO.	INJECTOR TYPE	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	MODE	REACT (SEC)
MMH	9	UNLIKE-DOUBLET	.024	.020	12.	60.	63.	41.7	66.8	50.	52.	1.49	.000	MIX	.180-05
MMH	10	UNLIKE-DOUBLET	.024	.020	12.	60.	74.	41.7	65.1	49.	52.	1.53	.000	MIX	.173-05
MMH	17	UNLIKE-DOUBLET	.024	.020	12.	60.	62.	35.6	48.5	52.	55.	1.75	.000	MIX	.142-05
MMH	18	UNLIKE-DOUBLET	.024	.020	12.	60.	61.	36.0	44.3	50.	56.	1.94	.000	MIX	.128-05
MMH	19	UNLIKE-DOUBLET	.024	.020	12.	60.	67.	42.2	56.1	100.	84.	1.75	.000	MIX	.488-05
MMH	20	UNLIKE-DOUBLET	.024	.020	12.	60.	69.	45.0	57.8	114.	84.	1.79	.000	MIX	.592-05
MMH	21	UNLIKE-DOUBLET	.024	.020	12.	60.	67.	52.6	73.2	109.	86.	1.66	.000	MIX	.727-05
MMH	22	UNLIKE-DOUBLET	.024	.020	12.	60.	114.	38.7	54.5	84.	88.	1.68	.000	MIX	.415-05
MMH	23	UNLIKE-DOUBLET	.024	.020	12.	60.	115.	50.0	71.6	88.	90.	1.65	.000	MIX	.585-05
MMH	24	UNLIKE-DOUBLET	.024	.020	12.	60.	166.	32.3	50.1	104.	88.	1.50	.000	MIX	.483-05
MMH	25	UNLIKE-DOUBLET	.024	.020	12.	60.	214.	31.3	46.5	103.	92.	1.57	.000	MIX	.473-05
MMH	30	UNLIKE-DOUBLET	.024	.020	12.	60.	109.	37.2	57.5	84.	77.	1.52	.000	MIX	.374-05
MMH	31	UNLIKE-DOUBLET	.024	.020	12.	60.	119.	46.1	65.5	81.	109.	1.69	.000	MIX	.669-05
MMH	32	UNLIKE-DOUBLET	.024	.020	12.	60.	114.	47.1	71.1	77.	121.	1.61	.000	MIX	.825-05
MMH	33	UNLIKE-DOUBLET	.024	.020	12.	60.	171.	32.6	45.3	76.	95.	1.72	.000	MIX	.353-05
MMH	35	UNLIKE-DOUBLET	.024	.020	12.	60.	69.	48.5	70.9	74.	115.	1.66	.000	MIX	.716-05
MMH	36	UNLIKE-DOUBLET	.024	.020	12.	60.	112.	38.4	56.1	74.	113.	1.66	.000	MIX	.553-05
MMH	37	UNLIKE-DOUBLET	.024	.020	12.	60.	117.	53.0	71.7	72.	136.	1.82	.000	SEP	.956-05
MMH	38	UNLIKE-DOUBLET	.024	.020	12.	60.	162.	38.0	50.5	73.	128.	1.84	.000	MIX	.618-05
MMH	39	UNLIKE-DOUBLET	.024	.020	12.	60.	185.	48.1	69.9	75.	136.	1.69	.000	SEP	.969-05
MMH	43	UNLIKE-DOUBLET	.040	.033	12.	60.	67.	36.7	48.2	89.	114.	1.86	.000	MIX	.157-04
MMH	45	UNLIKE-DOUBLET	.040	.033	12.	60.	71.	36.1	58.5	90.	117.	1.51	.000	MIX	.202-04
MMH	46	UNLIKE-DOUBLET	.040	.033	12.	60.	71.	51.9	65.5	89.	119.	1.94	.000	SEP	.232-04
MMH	48	UNLIKE-DOUBLET	.040	.033	12.	60.	122.	36.0	57.8	84.	116.	1.53	.000	MIX	.183-04
MMH	49	UNLIKE-DOUBLET	.040	.033	12.	60.	122.	49.5	69.8	85.	125.	1.75	.000	SEP	.259-04
MMH	50	UNLIKE-DOUBLET	.040	.033	12.	60.	122.	50.9	73.6	85.	129.	1.71	.000	SEP	.288-04
MMH	51	UNLIKE-DOUBLET	.040	.033	12.	60.	62.	40.7	44.7	97.	124.	2.22	.000	SEP	.188-04
MMH	52	UNLIKE-DOUBLET	.040	.033	12.	60.	113.	38.5	44.6	98.	107.	2.08	.000	MIX	.148-04
MMH	54	UNLIKE-DOUBLET	.040	.033	12.	60.	67.	54.3	54.4	96.	107.	2.41	.000	SEP	.177-04
MMH	55	UNLIKE-DOUBLET	.040	.033	12.	60.	114.	53.8	57.0	101.	121.	2.29	.000	SEP	.240-04
MMH	56	UNLIKE-DOUBLET	.040	.033	12.	60.	164.	53.1	56.3	99.	119.	2.29	.000	MIX	.224-04
MMH	59	UNLIKE-DOUBLET	.040	.033	12.	60.	64.	40.3	47.1	100.	131.	2.09	.000	SEP	.226-04
MMH	60	UNLIKE-DOUBLET	.040	.033	12.	60.	113.	57.9	60.4	98.	147.	2.37	.000	SEP	.351-04
MMH	63	UNLIKE-DOUBLET	.040	.033	12.	60.	64.	56.2	63.2	99.	164.	2.22	.000	SEP	.456-04
MMH	64	UNLIKE-DOUBLET	.040	.033	12.	60.	114.	42.0	44.1	99.	153.	2.36	.000	SEP	.280-04
MMH	66	UNLIKE-DOUBLET	.040	.033	12.	60.	111.	57.5	62.1	110.	192.	2.33	.000	SEP	.722-04
MMH	67	UNLIKE-DOUBLET	.024	.020	12.	60.	62.	38.5	54.8	103.	95.	1.64	.000	MIX	.590-05
MMH	68	UNLIKE-DOUBLET	.024	.020	12.	60.	61.	53.7	59.4	99.	95.	2.12	.000	MIX	.610-05
MMH	69	UNLIKE-DOUBLET	.024	.020	12.	60.	104.	37.4	34.1	96.	90.	2.57	.000	MIX	.307-05
MMH	70	UNLIKE-DOUBLET	.024	.020	12.	60.	104.	55.9	53.9	96.	96.	2.44	.000	MIX	.544-05

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR RCKTD

FUEL TYPE	TEST NO.	MODE	PC (PSIA)	VAVG	WEF	WEO	REF	REO	DELTI (DEG F)	RELF	RELO	PPF (PSIA)	PPO (PSIA)	MRVP	XF	XO	XP	RESID
MMH	9	MIX	63.	52.	2.3	1.3	.914+04	.243+05	0.	.11+06	.29+06	.5	8.6	36.4	.01	.14	.32-01	.25-04
MMH	10	MIX	74.	51.	2.5	1.5	.891+04	.243+05	0.	.11+06	.29+06	.5	8.4	35.6	.01	.11	.27-01	.26-04
MMH	17	MIX	62.	40.	1.2	.9	.685+04	.209+05	0.	.82+05	.25+06	.5	9.2	35.7	.01	.15	.35-01	.34-04
MMH	18	MIX	61.	39.	1.0	.9	.632+04	.209+05	0.	.76+05	.25+06	.5	8.6	32.5	.01	.14	.35-01	.38-04
MMH	19	MIX	67.	47.	1.8	1.8	.104+05	.329+05	0.	.12+06	.39+06	1.2	30.7	48.1	.02	.46	.92-01	.30-04
MMH	20	MIX	69.	50.	2.0	2.3	.107+05	.376+05	0.	.13+06	.45+06	1.2	42.5	64.9	.02	.62	.11+00	.29-04
MMH	21	MIX	67.	60.	3.1	3.0	.138+05	.428+05	0.	.17+06	.51+06	1.3	37.8	55.8	.02	.56	.10+00	.23-04
MMH	22	MIX	114.	45.	2.9	2.4	.104+05	.271+05	0.	.13+06	.33+06	1.4	21.1	31.2	.01	.18	.47-01	.31-04
MMH	23	MIX	115.	58.	5.0	4.1	.140+05	.360+05	0.	.17+06	.43+06	1.4	23.2	32.7	.01	.20	.50-01	.23-04
MMH	24	MIX	166.	39.	3.6	2.7	.960+04	.257+05	0.	.12+06	.31+06	1.4	33.9	48.4	.01	.20	.41-01	.33-04
MMH	25	MIX	214.	37.	4.0	3.3	.921+04	.248+05	0.	.11+06	.30+06	1.5	33.1	42.4	.01	.15	.33-01	.36-04
MMH	30	MIX	109.	45.	3.[illegible]	2.1	.100+05	.261+05	0.	.12+06	.31+06	1.0	21.1	40.4	.01	.19	.43-01	.29-04
MMH	31	MIX	119.	53.	4.5	3.5	.148+05	.317+05	0.	.18+06	.38+06	2.5	19.5	16.6	.02	.16	.58-01	.25-04
MMH	32	MIX	114.	56.	5.2	3.4	.176+05	.317+05	0.	.21+06	.38+06	3.4	17.7	11.4	.03	.16	.68-01	.23-04
MMH	33	MIX	171.	37.	3.0	2.4	.919+04	.218+05	0.	.11+06	.26+06	1.7	17.3	21.1	.01	.10	.32-01	.37-04
MMH	35	MIX	69.	57.	3.1	2.2	.168+05	.329+05	0.	.20+06	.38+06	2.8	16.5	12.7	.04	.24	.98-01	.24-04
MMH	36	MIX	112.	45.	3.1	2.2	.131+05	.254+05	0.	.16+06	.30+06	2.7	16.5	13.1	.02	.15	.59-01	.30-04
MMH	37	SEP	117.	60.	5.6	4.3	.197+05	.346+05	0.	.24+06	.42+06	4.8	15.6	7.5	.04	.13	.74-01	.23-04
MMH	38	MIX	162.	42.	3.8	3.1	.131+05	.249+05	0.	.16+06	.30+06	4.0	16.0	8.8	.02	.10	.50-01	.35-04
MMH	39	SEP	165.	56.	8.4	5.7	.192+05	.320+05	0.	.23+06	.38+06	4.8	16.9	7.9	.03	.09	.49-01	.24-04
MMH	43	MIX	69.	41.	2.4	2.2	.187+05	.443+05	0.	.22+06	.53+06	2.7	23.[illegible]	18.0	.04	.34	.12+00	.57-04
MMH	45	MIX	71.	45.	3.6	2.2	.232+05	.439+05	0.	.28+06	.53+06	3.0	24.2	17.0	.04	.34	.12+00	.47-04
MMH	46	SEP	71.	57.	4.5	4.6	.263+05	.626+05	0.	.32+06	.75+06	3.2	23.7	15.7	.04	.33	.12+00	.42-04
MMH	48	MIX	122.	45.	6.0	3.7	.227+05	.421+05	0.	.27+06	.51+06	2.9	21.1	15.4	.02	.17	.64-01	.48-04
MMH	49	SEP	122.	57.	8.9	7.0	.293+05	.582+05	0.	.35+06	.70+06	3.7	21.6	12.4	.03	.18	.74-01	.39-04
MMH	50	SEP	122.	59.	10.0	7.4	.318+05	.599+05	0.	.38+06	.72+06	4.1	21.6	11.3	.03	.18	.77-01	.37-04
MMH	51	SEP	62.	42.	1.9	2.6	.186+05	.518+05	0.	.22+06	.62+06	3.6	28.7	16.5	.06	.46	.17+00	.62-04
MMH	52	MIX	113.	40.	3.3	4.2	.164+05	.493+05	0.	.20+06	.59+06	2.4	29.4	25.3	.02	.26	.74-01	.62-04
MMH	54	SEP	67.	54.	2.9	4.9	.200+05	.686+05	0.	.24+06	.82+06	2.4	28.1	24.3	.04	.42	.12+00	.51-04
MMH	55	SEP	114.	55.	5.5	8.4	.232+05	.703+05	0.	.28+06	.84+06	3.4	31.5	19.[illegible]	.03	.28	.90-01	.48-04
MMH	56	MIX	164.	54.	7.7	11.7	.226+05	.685+05	0.	.27+06	.82+06	3.2	30.0	19.6	.02	.18	.60-01	.49-04
MMH	59	SEP	64.	42.	2.[illegible]	2.6	.206+05	.524+05	0.	.25+06	.63+06	4.3	30.7	15.1	.07	.48	.18+00	.56-04
MMH	60	SEP	113.	59.	6.4	9.5	.295+05	.742+05	0.	.35+06	.89+06	6.2	29.4	10.3	.06	.26	.12+00	.46-04
MMH	63	SEP	64.	58.	4.1	5.1	.345+05	.726+05	0.	.41+06	.87+06	8.8	30.0	7.6	.14	.47	.25+00	.44-04
MMH	64	SEP	114.	43.	3.5	5.1	.224+05	.542+05	0.	.27+06	.65+06	7.2	30.0	9.2	.06	.26	.13+00	.62-04
MMH	66	SEP	111.	59.	7.3	9.9	.496+05	.784+05	0.	.49+06	.94+06	16.0	38.6	5.5	.14	.35	.22+00	.44-04
MMH	67	MIX	62.	45.	1.6	1.4	.111+05	.304+05	0.	.13+06	.37+06	1.7	33.1	38.4	.03	.53	.12+00	.30-04
MMH	68	MIX	61.	56.	1.9	2.7	.121+05	.416+05	0.	.14+06	.50+06	1.7	30.0	35.2	.03	.49	.12+00	.28-04
MMH	69	MIX	104.	36.	1.0	2.2	.664+04	.284+05	0.	.80+05	.34+06	1.4	28.1	39.1	.01	.27	.61-01	.49-04
MMH	70	MIX	104.	55.	[illegible].6	4.8	.110+05	.424+05	0.	.13+06	.51+06	1.8	28.1	32.1	.02	.27	.67-01	.31-04

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HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR RCKTD

FUEL TYPE	TEST NO.	INJECTOR TYPE	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	MODE	REACT (SEC)
MMH	74	UNLIKE-DOUBLET	.024	.020	12.	60.	59.	39.8	41.7	97.	87.	2.23	.000	MIX	.366-05
MMH	75	UNLIKE-DOUBLET	.024	.020	12.	60.	106.	37.8	40.1	92.	92.	2.22	.000	MIX	.358-05
MMH	76	UNLIKE-DOUBLET	.024	.020	12.	60.	104.	53.6	52.1	88.	97.	2.44	.000	MIX	.486-05
MMH	82	UNLIKE-DOUBLET	.024	.020	12.	60.	62.	41.2	42.9	93.	101.	2.27	.000	UNDEF	.454-05
MMH	83	UNLIKE-DOUBLET	.024	.020	12.	60.	104.	39.1	39.7	86.	110.	2.36	.000	MIX	.438-05
MMH	84	UNLIKE-DOUBLET	.024	.020	12.	60.	154.	38.4	38.2	88.	123.	2.42	.000	MIX	.523-05
MMH	85	UNLIKE-DOUBLET	.024	.020	12.	60.	58.	38.3	47.4	101.	110.	1.91	.000	MIX	.623-05
MMH	86	UNLIKE-DOUBLET	.024	.020	12.	60.	58.	38.2	47.8	98.	125.	1.91	.000	UNDEF	.759-05
MMH	87	UNLIKE-DOUBLET	.024	.020	12.	60.	58.	38.5	48.1	97.	137.	1.93	.000	MIX	.880-05
MMH	88	UNLIKE-DOUBLET	.024	.020	12.	60.	59.	39.5	43.2	94.	117.	2.18	.000	MIX	.550-05
MMH	89	UNLIKE-DOUBLET	.024	.020	12.	60.	64.	38.6	41.0	94.	132.	2.27	.000	MIX	.683-05
MMH	90	UNLIKE-DOUBLET	.024	.020	12.	60.	64.	38.5	41.0	97.	143.	2.27	.000	MIX	.815-05
MMH	91	UNLIKE-DOUBLET	.024	.020	12.	60.	59.	53.7	60.4	94.	137.	2.15	.000	MIX	.107-04
MMH	92	UNLIKE-DOUBLET	.024	.020	12.	60.	62.	50.0	54.0	102.	159.	2.25	.000	MIX	.141-04
MMH	93	UNLIKE-DOUBLET	.024	.020	12.	60.	62.	49.2	54.3	103.	172.	2.22	.000	MIX	.169-04
MMH	98	UNLIKE-DOUBLET	.040	.033	12.	60.	25.	39.1	58.8	73.	78.	1.61	.000	MIX	.923-05
MMH	99	UNLIKE-DOUBLET	.040	.033	12.	60.	31.	43.9	57.8	74.	78.	1.84	.000	MIX	.919-05
MMH	100	UNLIKE-DOUBLET	.040	.033	12.	60.	51.	37.9	59.9	69.	81.	1.54	.000	UNDEF	.934-05
MMH	101	UNLIKE-DOUBLET	.040	.033	12.	60.	31.	39.5	61.4	71.	76.	1.56	.000	MIX	.908-05
MMH	102	UNLIKE-DOUBLET	.040	.033	12.	60.	74.	39.3	55.1	74.	81.	1.73	.000	MIX	.917-05
MMH	103	UNLIKE-DOUBLET	.040	.033	12.	60.	108.	40.1	54.6	73.	78.	1.78	.000	MIX	.857-05
MMH	104	UNLIKE-DOUBLET	.040	.033	12.	60.	113.	54.9	75.6	74.	79.	1.76	.000	MIX	.122-04
MMH	105	UNLIKE-DOUBLET	.040	.033	12.	60.	165.	38.7	58.4	71.	78.	1.61	.000	MIX	.892-05
MMH	106	UNLIKE-DOUBLET	.040	.033	12.	60.	34.	38.4	53.3	73.	90.	1.76	.000	MIX	.987-05
MMH	107	UNLIKE-DOUBLET	.040	.033	12.	60.	54.	38.9	53.2	71.	94.	1.79	.000	MIX	.104-04
MMH	118	UNLIKE-DOUBLET	.040	.033	12.	60.	36.	40.4	57.8	89.	78.	1.67	.000	MIX	.110-04
MMH	119	UNLIKE-DOUBLET	.040	.033	12.	60.	51.	40.7	54.8	88.	81.	1.78	.000	MIX	.108-04
MMH	120	UNLIKE-DOUBLET	.040	.033	12.	60.	69.	41.8	57.4	89.	79.	1.74	.000	MIX	.111-04
MMH	121	UNLIKE-DOUBLET	.040	.033	12.	60.	109.	39.6	54.3	96.	78.	1.73	.000	MIX	.113-04
MMH	122	UNLIKE-DOUBLET	.040	.033	12.	60.	108.	56.3	77.1	96.	83.	1.74	.000	MIX	.172-04
MMH	123	UNLIKE-DOUBLET	.040	.033	12.	60.	160.	39.3	53.5	96.	82.	1.75	.000	SEP	.118-04
MMH	124	UNLIKE-DOUBLET	.040	.033	12.	60.	38.	39.6	56.7	97.	83.	1.66	.000	SEP	.128-04
MMH	125	UNLIKE-DOUBLET	.040	.033	12.	60.	45.	53.5	77.6	99.	84.	1.64	.000	SEP	.182-04
MMH	126	UNLIKE-DOUBLET	.040	.033	12.	60.	42.	37.9	55.4	96.	102.	1.65	.000	MIX	.168-04
MMH	127	UNLIKE-DOUBLET	.040	.033	12.	60.	51.	38.9	56.9	97.	116.	1.66	.000	SEP	.211-04
MMH	128	UNLIKE-DOUBLET	.040	.033	12.	60.	69.	40.3	54.3	98.	123.	1.81	.000	SEP	.228-04
MMH	129	UNLIKE-DOUBLET	.040	.033	12.	60.	108.	38.0	55.3	98.	130.	1.68	.000	SEP	.256-04
MMH	130	UNLIKE-DOUBLET	.040	.033	12.	60.	106.	52.0	74.1	101.	148.	1.73	.000	SEP	.451-04
MMH	131	UNLIKE-DOUBLET	.040	.033	12.	60.	160.	37.5	50.9	100.	140.	1.81	.000	SEP	.271-04
MMH	132	UNLIKE-DOUBLET	.040	.033	12.	60.	38.	36.0	52.0	98.	137.	1.70	.000	MIX	.262-04

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR RCKTD

FUEL TYPE	TEST NO.	MODE	PC (PSIA)	VAVG	WEF	WEO	REF	REO	DELTI (DEG F)	RELF	RELO	PPF (PSIA)	PPO (PSIA)	MRVP	XF	XO	XP	RESID
MMH	74	MIX	59.	40.	.9	1.4	.793+04	.300+05	0.	.95+05	.36+06	1.3	28.7	42.5	.02	.49	.10+00	.40-04
MMH	75	MIX	106.	39.	1.5	2.2	.794+04	.279+05	0.	.95+05	.33+06	1.5	25.5	33.3	.01	.24	.59-01	.42-04
MMH	76	MIX	104.	53.	2.4	4.3	.107+05	.386+05	0.	.13+06	.46+06	1.8	23.2	26.1	.02	.22	.62-01	.32-04
MMH	82	UNDEF	62.	42.	1.0	1.5	.913+04	.306+05	0.	.11+06	.37+06	2.0	26.2	26.2	.03	.42	.12+00	.39-04
MMH	83	MIX	104.	39.	1.5	2.2	.905+04	.278+05	0.	.11+06	.33+06	2.5	22.1	18.3	.02	.21	.72-01	.42-04
MMH	84	MIX	154.	38.	2.0	3.2	.957+04	.276+05	0.	.11+06	.33+06	3.6	23.2	13.9	.02	.15	.59-01	.44-04
MMH	85	MIX	58.	41.	1.2	1.3	.108+05	.300+05	0.	.13+06	.36+06	2.5	31.5	25.3	.04	.54	.15+00	.35-04
MMH	86	UNDEF	58.	41.	1.2	1.3	.122+05	.294+05	0.	.15+06	.35+06	3.7	29.4	16.5	.06	.51	.18+00	.35-04
MMH	87	MIX	58.	42.	1.2	1.3	.133+05	.294+05	0.	.16+06	.35+06	4.9	28.7	12.7	.08	.50	.20+00	.35-04
MMH	88	MIX	59.	41.	1.0	1.4	.101+05	.296+05	0.	.12+06	.35+06	2.7	26.8	20.2	.05	.45	.15+00	.39-04
MMH	89	MIX	64.	39.	1.0	1.4	.109+05	.269+05	0.	.13+06	.35+06	4.4	26.8	13.0	.07	.42	.17+00	.41-04
MMH	90	MIX	64.	39.	1.0	1.4	.118+05	.294+05	0.	.14+06	.35+06	5.6	28.7	11.1	.09	.45	.20+00	.41-04
MMH	91	MIX	59.	56.	2.0	2.5	.167+05	.402+05	0.	.20+06	.48+06	4.9	26.8	11.9	.08	.45	.19+00	.26-04
MMH	92	MIX	62.	51.	1.7	2.4	.173+05	.393+05	0.	.21+06	.47+06	8.1	32.3	8.8	.13	.52	.26+00	.31-04
MMH	93	MIX	62.	51.	1.8	2.3	.189+05	.389+05	0.	.23+06	.47+06	10.7	33.1	6.9	.17	.53	.30+00	.31-04
MMH	98	MIX	25.	47.	1.2	.8	.171+05	.428+05	0.	.20+06	.51+06	1.1	16.0	30.5	.04	.64	.16+00	.47-04
MMH	99	MIX	31.	49.	1.4	1.3	.168+05	.484+05	0.	.20+06	.58+06	1.1	16.5	31.3	.03	.53	.13+00	.46-04
MMH	100	UNDEF	51.	47.	2.5	1.6	.179+05	.405+05	0.	.21+06	.49+06	1.1	14.5	25.7	.02	.28	.80-01	.46-04
MMH	101	MIX	31.	48.	1.6	1.1	.175+05	.428+05	0.	.21+06	.51+06	1.1	15.2	30.7	.03	.49	.13+00	.45-04
MMH	102	MIX	74.	45.	3.1	2.5	.164+05	.433+05	0.	.20+06	.52+06	1.1	16.5	29.0	.02	.22	.59-01	.50-04
MMH	103	MIX	108.	45.	4.5	3.8	.159+05	.439+05	0.	.19+06	.53+06	1.1	16.0	30.5	.01	.15	.38-01	.50-04
MMH	104	MIX	113.	62.	9.0	7.5	.221+05	.605+05	0.	.27+06	.73+06	1.1	16.5	30.5	.01	.15	.37-01	.36-04
MMH	105	MIX	165.	46.	7.8	5.4	.170+05	.419+05	0.	.20+06	.50+06	1.1	15.2	29.1	.01	.09	.24-01	.47-04
MMH	106	MIX	34.	44.	1.4	1.1	.171+05	.421+05	0.	.21+06	.50+06	1.4	16.0	23.3	.04	.47	.14+00	.52-04
MMH	107	MIX	54.	44.	2.2	1.8	.177+05	.421+05	0.	.21+06	.50+06	1.6	15.2	19.3	.03	.28	.92-01	.52-04
MMH	118	MIX	36.	47.	1.7	1.4	.168+05	.487+05	0.	.20+06	.58+06	1.1	23.7	43.8	.03	.66	.14+00	.48-04
MMH	119	MIX	51.	46.	2.1	2.0	.163+05	.488+05	0.	.20+06	.59+06	1.1	23.2	39.8	.02	.45	.10+00	.50-04
MMH	120	MIX	69.	47.	3.2	2.9	.168+05	.504+05	0.	.20+06	.60+06	1.1	23.7	42.7	.02	.34	.74-01	.48-04
MMH	121	MIX	109.	45.	4.4	4.2	.158+05	.500+05	0.	.19+06	.60+06	1.1	28.1	51.3	.01	.26	.50-01	.51-04
MMH	122	MIX	108.	64.	9.0	8.5	.234+05	.712+05	0.	.28+06	.85+06	1.2	28.1	45.4	.01	.26	.54-01	.36-04
MMH	123	SEP	160.	44.	6.4	6.2	.161+05	.497+05	0.	.19+06	.60+06	1.2	28.1	46.4	.01	.18	.36-01	.51-04
MMH	124	SEP	38.	46.	1.7	1.5	.172+05	.503+05	0.	.21+06	.60+06	1.2	28.7	46.3	.03	.76	.16+00	.49-04
MMH	125	SEP	45.	63.	3.6	3.3	.237+05	.691+05	0.	.28+06	.83+06	1.2	30.0	47.2	.03	.67	.14+00	.35-04
MMH	126	MIX	42.	45.	1.9	1.5	.196+05	.480+05	0.	.24+06	.58+06	2.1	28.1	27.3	.05	.67	.18+00	.50-04
MMH	127	SEP	51.	46.	2.4	1.9	.224+05	.495+05	0.	.27+06	.59+06	2.9	28.7	20.5	.06	.56	.18+00	.48-04
MMH	128	SEP	[illegible]	45.	3.0	2.8	.225+05	.517+05	0.	.27+06	.62+06	3.6	29.4	17.3	.05	.43	.15+00	.51-04
MMH	129	SEP	108.	44.	5.0	3.9	.240+05	.487+05	0.	.29+06	.58+06	4.2	29.4	14.8	.04	.27	.10+00	.50-04
MMH	130	SEP	[illegible]	66.	9.1	7.3	.364+05	.679+05	0.	.44+06	.81+06	6.4	31.5	10.7	.06	.30	.13+00	.37-04
MMH	131	SEP	160.	42.	6.4	5.7	.237+05	.487+05	0.	.28+06	.58+06	5.1	30.7	12.8	.03	.19	.79-01	.54-04
MMH	132	MIX	38.	42.	1.6	1.2	.237+05	.461+05	0.	.28+06	.55+06	4.9	29.4	12.9	.13	.77	.31+00	.53-04

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR RCKTD

FUEL TYPE	TEST NO.	INJECTOR TYPE	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	MODE	REACT (SEC)
MMH	133	UNLIKE-DOUBLET	.040	.033	12.	60.	45.	51.4	74.3	101.	183.	1.70	.000	MIX	.421-04
MMH	134	UNLIKE-DOUBLET	.040	.033	12.	60.	37.	35.9	55.8	95.	142.	1.59	.000	SEP	.290-04
MMH	135	UNLIKE-DOUBLET	.040	.033	12.	60.	56.	37.5	54.3	98.	142.	1.70	.000	SEP	.292-04
MMH	136	UNLIKE-DOUBLET	.040	.033	12.	60.	69.	38.5	55.0	102.	152.	1.73	.000	SEP	.358-04
MMH	137	UNLIKE-DOUBLET	.040	.033	12.	60.	110.	37.3	54.9	103.	155.	1.68	.000	SEP	.375-04
MMH	138	UNLIKE-DOUBLET	.040	.033	12.	60.	106.	52.0	75.5	107.	168.	1.71	.000	SEP	.633-04
MMH	140	UNLIKE-DOUBLET	.040	.033	12.	60.	40.	35.6	55.2	66.	155.	1.65	.000	SEP	.242-04
MMH	141	UNLIKE-DOUBLET	.040	.033	12.	60.	39.	34.6	54.2	55.	169.	1.66	.000	SEP	.244-04
MMH	142	UNLIKE-DOUBLET	.040	.033	12.	60.	52.	36.0	51.1	60.	157.	1.81	.000	SEP	.213-04
MMH	143	UNLIKE-DOUBLET	.040	.033	12.	60.	52.	35.4	50.2	54.	172.	1.84	.000	SEP	.232-04
MMH	144	UNLIKE-DOUBLET	.040	.033	12.	60.	71.	35.9	54.2	57.	167.	1.72	.000	SEP	.244-04
MMH	145	UNLIKE-DOUBLET	.040	.033	12.	60.	72.	35.3	53.4	53.	175.	1.73	.000	SEP	.252-04

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR RCKTD

FUEL TYPE	TEST NO.	MODE	PC (PSIA)	VAVG	WEF	WEO	REF	REO	DELTI (DEG F)	RELF	RELO	PPF (PSIA)	PPO (PSIA)	MRVP	XF	XO	XP	RESID
MMH	133	MIX	45.	60.	3.8	3.0	.353+05	.67[illegible]+05	0.	.42+06	.80+06	5.6	31.5	12.1	.12	.70	.30+00	.37-04
MMH	134	SEP	37.	44.	1.8	1.2	.263+05	.451+[illegible]	0.	.32+06	.54+06	5.5	27.5	10.9	.15	.74	.35+00	.49-04
MMH	135	SEP	56.	44.	2.6	2.0	.256+05	.48[illegible]+05	0.	.31+06	.58+05	5.5	29.4	11.6	.10	.52	.23+00	.51-04
MMH	136	SEP	69.	45.	3.3	2.6	.278+05	.505+0[illegible]	[illegible].	.33+06	.61+06	7.0	32.3	10.0	.10	.47	.22+00	.50-04
MMH	137	SEP	110.	44.	5.3	4.0	.263+05	.492+05	[illegible].	.34+06	.59+06	7.5	33.1	9.7	.07	.30	.14+00	.50-04
MMH	138	SEP	106.	61.	9.8	7.6	.423+05	.696+05	0.	.51+06	.84+06	9.7	36.2	8.2	.09	.34	.18+00	.36-04
MMH	140	SEP	40.	43.	1.9	1.1	.284+05	.375+05	0.	.34+06	.45+06	7.5	13.5	[illegible]	.19	.34	.25+00	.50-04
MMH	141	SEP	39.	42.	1.9	.9	.3[illegible]6+05	.344+05	0.	.37+06	.41+06	10.0	10.1	2.5	.26	.26	.26+09	.51-04
MMH	142	SEP	52.	41.	2.2	1.4	.267+05	.367+05	0.	.32+06	.44+06	7.8	11.7	3.6	.15	.22	.18+00	.54-04
MMH	143	SEP	52.	41.	2.1	1.3	.289+05	.350+05	0.	.35+06	.42+06	10.7	9.8	2.2	.21	.19	.20+00	.55-04
MMH	144	SEP	71.	43.	3.4	1.9	.302+05	.361+05	0.	.36+06	.43+06	9.5	10.7	2.7	.13	.1[illegible]	.14+00	.51-04
MMH	145	SEP	72.	42.	3.4	1.8	.313+05	.348+05	0.	.38+06	.42+06	11.5	9.5	2.0	.16	.13	.14+00	.51-04

ZETA PLOT FILE HAS BEEN CREATED... 5328 CHARACTERS

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HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR ZUNG

FUEL TYPE	TEST NO.	INJECTOR TYPE	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	MODE	REACT (SEC)
N2H4	15	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	23.0	35.0	70.	70.	.94	1.620	SEP	.849-06
N2H4	28	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	44.0	75.0	70.	70.	.84	2.050	SEP	.182-05
N2H4	58	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	55.0	46.0	69.	69.	1.78	.470	MIX	.108-05
N2H4	61	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	42.0	40.0	70.	70.	1.50	.640	SEP	.970-06
N2H4	63	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	41.0	52.0	67.	70.	1.14	1.100	MIX	.122-05
N2H4	64	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	45.0	53.0	65.	68.	1.21	1.020	MIX	.117-05
N2H4	68	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	71.0	78.0	70.	70.	1.29	.860	SEP	.189-05
N2H4	79	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	20.0	25.0	70.	70.	1.11	1.160	SEP	.606-06
N2H4	80	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	41.0	54.0	68.	68.	1.09	1.220	MIX	.124-05
N2H4	81	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	34.0	53.0	70.	70.	.91	1.750	SEP	.129-05
N2H4	82	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	40.0	52.0	70.	70.	.02	1.700	SEP	.126-05
N2H4	83	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	41.0	52.0	70.	70.	1.08	1.200	SEP	.126-05
N2H4	85	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	38.0	48.0	70.	70.	1.02	1.080	SEP	.116-05
N2H4	89	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	19.0	24.0	67.	68.	1.10	1.180	MIX	.544-06
N2H4	90	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	53.0	94.0	67.	67.	.82	2.180	MIX	.209-05
N2H4	91	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	53.0	94.0	70.	70.	.82	2.180	SEP	.228-05
N2H4	92	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	65.0	92.0	70.	70.	1.02	1.380	SEP	.223-05
N2H4	93	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	43.0	60.0	60.	60.	1.04	1.310	MIX	.106-05
N2H4	94	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	39.0	56.0	45.	45.	1.31	.830	MIX	.589-06
N2H4	95	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	61.0	67.0	45.	45.	1.31	.830	MIX	.704-06
N2H4	96	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	22.0	29.0	45.	45.	1.08	1.230	MIX	.305-06
N2H4	98	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	23.0	29.0	45.	45.	1.11	1.170	MIX	.305-06
N2H4	99	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	40.0	64.0	80.	80.	.89	1.800	SEP	.205-05
N2H4	100	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	20.0	33.0	75.	80.	.84	2.200	SEP	.998-06
N2H4	101	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	20.0	36.0	79.	83.	.80	2.280	SEP	.123-05
N2H4	102	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	16.0	24.0	78.	82.	1.10	1.200	UNDEF	.793-06
N2H4	108	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	47.0	36.0	70.	95.	1.89	.410	SEP	.140-05
N2H4	109	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	42.0	30.0	70.	95.	2.01	.410	SEP	.117-05
N2H4	110	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	25.0	31.0	70.	95.	1.18	1.060	SEP	.120-05
N2H4	111	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	23.0	24.0	65.	65.	1.38	.760	MIX	.502-06
N2H4	112	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	27.0	33.0	65.	65.	1.16	1.070	MIX	.690-06
N2H4	113	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	24.0	33.0	70.	110.	1.04	1.330	SEP	.167-05
N2H4	114	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	18.0	27.0	70.	105.	.96	1.590	SEP	.125-05
N2H4	116	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	18.0	22.0	70.	105.	.96	1.580	UNDEF	.102-05
N2H4	117	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	16.0	25.0	70.	80.	.96	1.580	UNDEF	.707-06
N2H4	118	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	52.0	70.0	70.	80.	1.07	1.280	UNDEF	.978-05
N2H4	119	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	14.0	17.0	70.	80.	1.23	.950	SEP	.237-05
N2H4	120	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	17.0	22.0	70.	80.	1.12	1.150	UNDEF	.307-05
N2H4	121	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	36.0	48.0	70.	80.	1.09	1.210	UNDEF	.671-05
N2H4	122	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	68.0	93.0	70.	80.	1.06	1.280	UNDEF	.130-04

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR ZUNG

FUEL TYPE	TEST NO.	MODE	PC (PSIA)	VAVG	WEF	WEO	REF	REO	DELTI (DEG F)	RELF	RELO	PPF (PSIA)	PPO (PSIA)	MRVP	XF	XO	XP	RESID
N2H4	15	SEP	15.	29.	.1	.1	.754+04	.167+05	0.	.30+05	.67+05	.2	14.8	173.4	.02	1.01	.13+00	.64-04
N2H4	28	SEP	15.	61.	.5	.4	.162+05	.320+05	0.	.65+05	.13+06	.2	14.8	173.4	.02	1.01	.13+00	.30-04
N2H4	58	MIX	15.	52.	.2	.6	.983+04	.397+05	0.	.39+05	.16+06	.2	14.5	175.2	.02	.98	.13+00	.49-04
N2H4	61	SEP	15.	41.	.1	.4	.862+04	.305+05	0.	.34+05	.12+06	.2	14.8	173.4	.02	1.01	.13+00	.56-04
N2H4	63	MIX	15.	46.	.2	.4	.112+05	.293+05	0.	.45+05	.12+06	.2	13.8	163.4	.02	.94	.13+00	.43-04
N2H4	64	MIX	15.	49.	.2	.4	.112+05	.318+05	0.	.45+05	.13+06	.2	13.2	166.3	.02	.90	.12+00	.42-04
N2H4	68	SEP	15.	74.	.5	1.1	.168+05	.516+05	0.	.67+05	.21+06	.2	14.8	173.4	.02	1.01	.13+00	.29-04
N2H4	79	SEP	15.	22.	.1	.1	.539+04	.145+05	0.	.22+05	.58+05	.2	14.8	173.4	.02	1.01	.13+00	.90-04
N2H4	80	MIX	15.	47.	.2	.4	.115+05	.295+05	0.	.46+05	.12+06	.2	14.2	177.0	.02	.96	.12+00	.42-04
N2H4	81	SEP	15.	44.	.2	.2	.114+05	.247+05	0.	.46+05	.99+05	.2	14.8	173.4	.02	1.01	.13+00	.42-04
N2H4	82	SEP	15.	52.	.2	.3	.112+05	.291+05	0.	.45+05	.12+06	.2	14.8	173.4	.02	1.01	.13+00	.43-04
N2H4	83	SEP	15.	46.	.2	.4	.112+05	.298+05	0.	.45+05	.12+06	.2	14.8	173.4	.02	1.01	.13+00	.43-04
N2H4	85	SEP	15.	43.	.2	.3	.103+05	.276+05	0.	.41+05	.11+06	.2	14.8	173.4	.02	1.01	.13+00	.47-04
N2H4	89	MIX	15.	21.	.0	.1	.509+04	.136+05	0.	.20+05	.54+05	.2	13.8	173.4	.02	.94	.12+00	.94-04
N2H4	90	MIX	15.	76.	.7	.6	.198+05	.379+05	0.	.79+05	.15+06	.2	13.8	178.9	.02	.94	.12+00	.24-04
N2H4	91	SEP	15.	76.	.7	.6	.202+05	.385+05	0.	.81+05	.15+06	.2	14.8	173.4	.02	1.01	.13+00	.24-04
N2H4	92	SEP	15.	78.	.7	.9	.198+05	.472+05	0.	.79+05	.19+06	.2	14.8	173.4	.02	1.01	.13+00	.24-04
N2H4	93	MIX	15.	51.	.3	.4	.120+05	.296+05	0.	.48+05	.12+06	.2	11.7	197.4	.01	.79	.96-01	.37-04
N2H4	94	MIX	15.	46.	.2	.3	.101+05	.256+05	0.	.40+05	.10+06	.1	7.6	221.1	.01	.52	.59-01	.40-04
N2H4	95	MIX	15.	64.	.4	.7	.121+05	.401+05	0.	.48+05	.16+06	.1	7.6	221.1	.01	.52	.59-01	.34-04
N2H4	96	MIX	15.	25.	.1	.1	.523+04	.145+05	0.	.21+05	.58+05	.1	7.6	221.1	.01	.52	.59-01	.78-04
N2H4	98	MIX	15.	26.	.1	.1	.523+04	.151+05	0.	.21+05	.60+05	.1	7.6	221.1	.01	.52	.59-01	.78-04
N2H4	99	SEP	15.	53.	.3	.4	.150+05	.308+05	0.	.60+05	.12+06	.3	19.0	170.5	.02	1.29	.17+00	.35-04
N2H4	100	SEP	15.	27.	.1	.1	.772+04	.149+05	0.	.31+05	.60+05	.3	16.9	153.1	.02	1.15	.16+00	.68-04
N2H4	101	SEP	15.	29.	.1	.1	.863+04	.153+05	0.	.35+05	.61+05	.4	18.6	145.5	.03	1.26	.18+00	.63-04
N2H4	102	UNDEF	15.	21.	.0	.1	.571+04	.137+05	0.	.23+05	.55+05	.4	18.1	148.8	.02	1.23	.17+00	.94-04
N2H4	106	SEP	15.	43.	.1	.5	.956+04	.341+05	0.	.38+05	.14+06	.6	14.8	78.4	.04	1.01	.20+00	.63-04
N2H4	109	SEP	15.	38.	.1	.4	.796+04	.305+05	0.	.32+05	.12+06	.6	14.8	78.4	.04	1.01	.20+00	.75-04
N2H4	110	SEP	15.	28.	.1	.1	.823+04	.182+05	0.	.33+05	.73+05	.6	14.8	78.4	.04	1.01	.20+00	.73-04
N2H4	111	MIX	15.	23.	.0	.1	.497+04	.163+05	0.	.20+05	.65+05	.2	13.2	183.2	.01	.90	.11+00	.94-04
N2H4	112	MIX	15.	30.	.1	.2	.684+04	.191+05	0.	.27+05	.76+05	.2	13.2	183.2	.01	.90	.11+00	.68-04
N2H4	113	SEP	15.	25.	.1	.1	.968+04	.174+05	0.	.39+05	.70+05	.9	14.8	50.8	.06	1.01	.25+00	.68-04
N2H4	114	SEP	15.	23.	.1	.1	.771+04	.131+05	0.	.31+05	.52+05	.8	14.8	58.4	.05	1.01	.23+00	.83-04
N2H4	116	UNDEF	15.	20.	.0	.1	.628+04	.131+05	0.	.25+05	.52+05	.8	14.8	58.4	.05	1.01	.23+00	.10-03
N2H4	117	UNDEF	15.	21.	.1	.1	.585+04	.116+05	0.	.23+05	.46+05	.3	14.8	135.3	.02	1.01	.15+00	.90-04
N2H4	118	UNDEF	15.	61.	.9	1.3	.364+05	.840+05	0.	.15+06	.34+06	.3	14.8	135.3	.02	1.01	.15+00	.71-04
N2H4	119	SEP	15.	15.	.1	.1	.884+04	.226+05	0.	.35+05	.90+05	.3	14.8	135.3	.02	1.01	.15+00	.29-03
N2H4	120	UNDEF	15.	19.	.1	.1	.114+05	.274+05	0.	.46+05	.11+06	.3	14.8	135.3	.02	1.01	.15+00	.23-03
N2H4	121	UNDEF	15.	42.	.4	.6	.250+05	.581+05	0.	.10+06	.23+06	.3	14.8	135.3	.02	1.01	.15+00	.10-03
N2H4	122	UNDEF	15.	40.	1.0	2.2	.484+05	.110+06	0.	.19+06	.44+06	.3	14.8	135.3	.02	1.01	.15+00	.54-04

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HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR ZUNG

FUEL TYPE	TEST NO.	INJECTOR TYPE	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	MODE	REACT (SEC)
N2H4	123	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	13.0	18.0	75.	75.	1.16	1.060	SEP	.250-05
N2H4	124	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	8.3	13.0	71.	72.	.95	1.060	SEP	.163-05
N2H4	125	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	6.6	11.0	71.	72.	.89	1.810	SEP	.138-05
N2H4	126	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	5.4	8.6	72.	72.	.90	1.770	SEP	.110-05
N2H4	127	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	4.3	5.6	72.	72.	1.10	1.170	SEP	.713-06
N2H4	128	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	13.0	16.0	40.	50.	1.11	1.150	POP	.872-06
N2H4	129	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	9.1	14.0	42.	52.	.96	1.560	POP	.818-06
N2H4	130	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	8.3	10.0	42.	52.	1.18	1.010	POP	.585-06
N2H4	131	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	8.0	9.0	42.	52.	1.27	.880	POP	.526-06
N2H4	132	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	10.0	7.9	45.	52.	1.83	.430	POP	.480-06
N2H4	133	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	9.9	12.0	45.	50.	1.18	1.000	POP	.700-06
N2H4	134	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	9.3	13.0	47.	50.	1.00	1.420	POP	.778-06
N2H4	135	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	4.3	8.6	63.	62.	.71	2.810	POP	.814-06
N2H4	136	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	12.0	14.0	54.	54.	1.17	1.050	POP	.101-05
N2H4	137	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	8.2	12.0	55.	55.	1.04	1.540	POP	.892-06
N2H4	139	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	9.6	12.0	61.	61.	1.13	1.110	POP	.108-05
N2H4	140	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	14.0	20.0	63.	63.	.98	1.470	POP	.193-05
N2H4	141	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	22.0	26.0	66.	70.	1.20	.990	POP	.132-05
N2H4	142	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	18.0	21.0	70.	70.	1.22	.950	SEP	.112-05
N2H4	143	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	13.0	17.0	70.	70.	1.07	1.250	SEP	.905-06
N2H4	144	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	12.0	14.0	70.	70.	1.18	1.030	SEP	.745-06
N2H4	148	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	21.0	17.0	72.	92.	1.71	.490	SEP	.142-05
N2H4	149	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	24.0	28.0	68.	68.	1.21	.970	MIX	.141-05
N2H4	150	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	24.0	28.0	67.	59.	1.20	.980	POP	.116-05
N2H4	151	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	16.0	19.0	62.	65.	1.22	1.290	POP	.840-06
N2H4	152	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	14.0	19.0	63.	63.	1.01	1.400	MIX	.816-06
N2H4	164	UNLIKE-DOUBLET	.040	.040	4.	60.	149.	16.0	22.0	69.	73.	1.07	1.250	MIX	.122-05
N2H4	165	UNLIKE-DOUBLET	.040	.040	4.	60.	189.	23.0	23.0	67.	73.	1.44	.690	MIX	.125-05
N2H4	166	UNLIKE-DOUBLET	.040	.040	4.	60.	187.	24.0	23.0	66.	73.	1.47	.650	MIX	.123-05
N2H4	167	UNLIKE-DOUBLET	.040	.040	4.	60.	189.	23.0	25.0	47.	59.	1.35	.790	MIX	.786-06
N2H4	169	UNLIKE-DOUBLET	.040	.040	4.	60.	209.	24.0	27.0	40.	52.	1.31	.840	UNDEF	.682-06
N2H4	170	UNLIKE-DOUBLET	.040	.040	4.	60.	111.	15.0	15.0	40.	58.	1.45	.680	MIX	.423-06
N2H4	171	UNLIKE-DOUBLET	.040	.040	4.	60.	191.	23.0	27.0	43.	58.	1.25	.920	MIX	.793-06
N2H4	174	UNLIKE-DOUBLET	.040	.040	4.	60.	172.	22.0	27.0	54.	64.	1.20	.990	MIX	.105-05
N2H4	175	UNLIKE-DOUBLET	.040	.040	4.	60.	187.	22.0	27.0	57.	65.	1.20	.990	MIX	.112-05
N2H4	179	UNLIKE-DOUBLET	.040	.040	4.	60.	163.	21.0	23.0	56.	63.	1.30	.840	MIX	.899-06
N2H4	180	UNLIKE-DOUBLET	.040	.040	4.	60.	165.	19.0	24.0	76.	81.	1.55	1.070	MIX	.166-05
N2H4	181	UNLIKE-DOUBLET	.040	.040	4.	60.	140.	18.0	20.0	77.	82.	1.23	.940	MIX	.143-05
N2H4	182	UNLIKE-DOUBLET	.040	.040	4.	60.	259.	20.0	19.0	81.	87.	1.47	.660	UNDEF	.160-05
N2H4	183	UNLIKE-DOUBLET	.040	.040	4.	60.	157.	19.0	29.0	85.	93.	.94	1.610	MIX	.289-05

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HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR ZUNG

FUEL TYPE	TEST NO.	MODE	PC (PSIA)	VAVG	WEF	WEO	RFF	REO	DELTI (DEG F)	RELF	RELO	PPF (PSIA)	PPO (PSIA)	MRVP	XF	XO	XP	RESID
N2H4	123	SEP	15.	15.	.1	.1	.897+04	.216+05	0.	.36+05	.86+05	.3	16.9	171.8	.02	1.15	.15+00	.23-03
N2H4	124	SEP	15.	11.	.0	.0	.632+04	.135+05	0.	.25+05	.54+05	.3	15.2	168.4	.02	1.03	.14+00	.38-03
N2H4	125	SEP	15.	9.	.0	.0	.535+04	.107+05	0.	.21+05	.43+05	.3	15.2	168.4	.02	1.03	.14+00	.45-03
N2H4	126	SEP	15.	7.	.0	.0	.418+04	.882+04	0.	.17+05	.35+05	.3	15.6	172.7	.02	1.06	.14+00	.56-03
N2H4	127	SEP	15.	5.	.0	.0	.272+04	.702+04	0.	.11+05	.28+05	.3	15.6	172.7	.02	1.06	.14+00	.89-03
N2H4	128	PUP	15.	14.	.0	.1	.662+04	.191+05	0.	.26+05	.76+05	.1	6.6	158.6	.01	.45	.61-01	.37-03
N2H4	129	PUP	15.	12.	.0	.0	.587+04	.133+05	0.	.23+05	.53+05	.1	7.0	155.8	.01	.48	.65-01	.36-03
N2H4	130	PUP	15.	9.	.0	.0	.420+04	.122+05	0.	.17+05	.49+05	.1	7.0	155.8	.01	.48	.65-01	.50-03
N2H4	131	PUP	15.	8.	.0	.0	.378+04	.117+05	0.	.15+05	.47+05	.1	7.0	155.8	.01	.48	.65-01	.56-03
N2H4	132	PUP	15.	9.	.0	.0	.331+04	.146+05	0.	.13+05	.58+05	.1	7.6	167.7	.01	.52	.66-01	.63-03
N2H4	133	PUP	15.	11.	.0	.0	.497+04	.145+05	0.	.20+05	.58+05	.1	7.6	180.0	.01	.52	.66-01	.42-03
N2H4	134	PUP	15.	11.	.0	.0	.538+04	.136+05	0.	.22+05	.54+05	.1	8.0	168.4	.01	.54	.67-01	.38-03
N2H4	135	PUP	15.	7.	.0	.0	.387+04	.668+04	0.	.15+05	.27+05	.2	12.6	195.5	.01	.86	.10+00	.58-03
N2H4	136	PUP	15.	13.	.0	.1	.596+04	.178+05	0.	.24+05	.71+05	.1	9.8	199.2	.01	.67	.80-01	.36-03
N2H4	137	PUP	15.	10.	.0	.0	.514+04	.122+05	0.	.21+05	.49+05	.1	10.1	198.8	.01	.69	.83-01	.42-03
N2H4	139	PUP	15.	11.	.0	.0	.536+04	.148+05	0.	.21+05	.59+05	.2	12.0	194.1	.01	.82	.99-01	.42-03
N2H4	140	PUP	15.	17.	.1	.1	.907+04	.218+05	0.	.36+05	.87+05	.2	12.6	188.2	.01	.86	.11+00	.25-03
N2H4	141	PUP	15.	24.	.1	.2	.830+04	.232+05	0.	.33+05	.93+05	.2	13.5	160.0	.02	.92	.12+00	.13-03
N2H4	142	SEP	15.	19.	.1	.1	.670+04	.194+05	0.	.27+05	.77+05	.2	14.8	173.4	.02	1.01	.13+00	.16-03
N2H4	143	SEP	15.	15.	.0	.1	.543+04	.140+05	0.	.22+05	.56+05	.2	14.8	173.4	.02	1.01	.13+00	.20-03
N2H4	144	SEP	15.	13.	.0	.0	.447+04	.129+05	0.	.18+05	.52+05	.2	14.8	173.4	.02	1.01	.13+00	.24-03
N2H4	148	SEP	15.	20.	.0	.1	.651+04	.229+05	0.	.26+05	.91+05	.5	15.6	90.0	.04	1.06	.19+00	.20-03
N2H4	149	MIX	15.	26.	.1	.2	.880+04	.255+05	0.	.35+05	.10+06	.2	14.2	177.0	.02	.96	.12+00	.12-03
N2H4	150	PUP	15.	20.	.1	.2	.823+04	.254+05	0.	.33+05	.10+06	.2	13.8	237.3	.01	.94	.10+00	.12-03
N2H4	151	PUP	15.	17.	.0	.1	.583+04	.165+05	0.	.23+05	.66+05	.2	12.3	171.3	.01	.84	.11+00	.18-03
N2H4	152	MIX	15.	16.	.0	.1	.575+04	.145+05	0.	.23+05	.58+05	.2	12.6	188.2	.01	.86	.11+00	.16-03
N2H4	164	MIX	139.	19.	.6	.8	.719+04	.171+05	0.	.29+05	.68+05	.3	14.5	156.7	.00	.10	.13-01	.15-03
N2H4	165	MIX	189.	23.	.8	2.1	.752+04	.243+05	0.	.30+05	.97+05	.3	13.8	150.5	.00	.07	.10-01	.14-03
N2H4	166	MIX	187.	24.	.8	2.3	.752+04	.253+05	0.	.30+05	.10+06	.3	13.5	147.4	.00	.07	.10-01	.14-03
N2H4	167	MIX	194.	24.	1.0	1.9	.734+04	.224+05	0.	.29+05	.89+05	.2	8.0	142.1	.00	.04	.61-02	.13-03
N2H4	169	[illegible]	209.	25.	1.2	2.5	.755+04	.235+05	0.	.30+05	.94+05	.1	6.6	147.8	.00	.03	.45-02	.12-03
N2H4	170	MIX	111.	15.	.2	.5	.437+04	.147+05	0.	.17+05	.59+05	.2	6.6	123.0	.00	.06	.93-02	.22-03
N2H4	171	MIX	191.	25.	1.1	1.9	.787+04	.224+05	0.	.31+05	.90+05	.2	7.2	132.9	.00	.04	.56-02	.12-03
N2H4	174	MIX	172.	24.	1.0	1.7	.823+04	.218+05	0.	.33+05	.87+05	.2	9.8	143.7	.00	.06	.81-02	.12-03
N2H4	175	MIX	187.	[illegible]	1.1	1.8	.829+04	.221+05	0.	.33+05	.88+05	.2	10.7	151.1	.00	.06	.80-02	.12-03
N2H4	179	MIX	163.	22.	.7	1.5	.696+04	.210+05	0.	.28+05	.84+05	.2	10.4	157.8	.00	.06	.87-02	.14-03
N2H4	180	MIX	165.	21.	.9	1.3	.839+04	.212+05	0.	.34+05	.85+05	.3	17.3	149.2	.00	.10	.15-01	.14-03
N2H4	181	MIX	140.	17.	.5	1.0	.704+04	.202+05	0.	.28+05	.81+05	.4	17.7	145.7	.00	.13	.18-01	.17-03
N2H4	182	[illegible]	259.	20.	.8	2.4	.697+04	.229+05	0.	.28+05	.92+05	.4	19.5	130.2	.00	.08	.11-01	.18-03
N2H4	183	MIX	157.	24.	1.2	1.3	.112+05	.223+05	0.	.45+05	.89+05	.5	21.6	117.9	.00	.14	.22-01	.11-03

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HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR ZUNG

FUEL TYPE	TEST NO.	INJECTOR TYPE	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	MODE	REACT (SEC)
N2H4	184	UNLIKE-DOUBLET	.040	.040	4.	60.	119.	17.0	14.0	95.	101.	1.83	.430	MIX	.180-05
N2H4	185	UNLIKE-DOUBLET	.040	.040	4.	60.	131.	17.0	17.0	107.	96.	1.41	.720	MIX	.231-05
N2H4	186	UNLIKE-DOUBLET	.040	.040	4.	60.	155.	22.0	24.0	77.	91.	1.31	.840	MIX	.209-05
N2H4	187	UNLIKE-DOUBLET	.040	.040	4.	60.	194.	27.0	27.0	91.	91.	1.41	.720	MIX	.278-05
N2H4	188	UNLIKE-DOUBLET	.030	.040	4.	60.	194.	26.0	29.0	86.	90.	1.24	.920	MIX	.277-05
N2H4	191	UNLIKE-DOUBLET	.040	.040	4.	60.	170.	25.0	25.0	96.	103.	1.42	.710	MIX	.338-05
N2H4	192	UNLIKE-DOUBLET	.040	.040	4.	60.	152.	24.0	27.0	104.	115.	1.27	.890	MIX	.475-05
N2H4	193	UNLIKE-DOUBLET	.040	.040	4.	60.	174.	25.0	31.0	94.	99.	1.14	1.100	MIX	.379-05
N2H4	194	UNLIKE-DOUBLET	.040	.040	4.	60.	169.	24.0	30.0	100.	104.	1.13	1.120	MIX	.432-05
N2H4	196	UNLIKE-DOUBLET	.040	.040	4.	60.	194.	24.0	32.0	76.	94.	1.09	1.210	MIX	.290-05
N2H4	197	UNLIKE-DOUBLET	.040	.040	4.	60.	187.	16.0	32.0	106.	76.	.72	2.790	MIX	.291-05
N2H4	198	UNLIKE-DOUBLET	.040	.040	4.	60.	164.	24.0	27.0	91.	101.	1.25	.920	MIX	.330-05
N2H4	199	UNLIKE-DOUBLET	.040	.040	4.	60.	181.	23.0	32.0	93.	108.	1.03	1.360	MIX	.457-05
N2H4	200	UNLIKE-DOUBLET	.040	.040	4.	60.	203.	23.0	32.0	64.	77.	1.04	1.320	MIX	.178-05
N2H4	201	UNLIKE-DOUBLET	.040	.040	4.	60.	178.	20.0	32.0	62.	77.	.92	1.680	MIX	.174-05
N2H4	204	UNLIKE-DOUBLET	.040	.040	4.	60.	110.	31.0	36.0	52.	64.	1.23	.950	MIX	.135-05
N2H4	205	UNLIKE-DOUBLET	.040	.040	4.	60.	115.	33.0	35.0	76.	84.	1.36	1.360	MIX	.260-05
N2H4	206	UNLIKE-DOUBLET	.040	.040	4.	60.	115.	33.0	30.0	91.	95.	1.59	1.590	MIX	.332-05
N2H4	207	UNLIKE-DOUBLET	.040	.040	4.	60.	110.	29.0	34.0	110.	107.	1.23	1.230	MIX	.580-05
N2H4	208	UNLIKE-DOUBLET	.040	.040	4.	60.	110.	28.0	40.0	102.	108.	.99	1.440	MIX	.634-05
N2H4	209	UNLIKE-DOUBLET	.040	.040	4.	60.	110.	29.0	35.0	105.	110.	1.19	.990	MIX	.594-05
N2H4	210	UNLIKE-DOUBLET	.040	.040	4.	60.	110.	29.0	37.0	121.	[illegible]	1.12	1.130	MIX	.750-05
N2H4	211	UNLIKE-DOUBLET	.040	.040	4.	60.	110.	30.0	35.0	121.	[illegible]	1.24	.930	MIX	.777-05
N2H4	212	UNLIKE-DOUBLET	.040	.040	4.	60.	110.	30.0	35.0	121.	118.	1.24	.930	MIX	.799-05
N2H4	215	UNLIKE-DOUBLET	.040	.040	4.	60.	110.	56.0	68.0	108.	118.	1.17	.850	MIX	.134-04
N2H4	217	UNLIKE-DOUBLET	.040	.040	4.	60.	110.	56.0	68.0	93.	101.	1.17	.850	MIX	.852-05
N2H4	219	UNLIKE-DOUBLET	.040	.040	4.	60.	110.	56.0	63.0	123.	121.	1.27	.790	MIX	.154-04
N2H4	220	UNLIKE-DOUBLET	.040	.040	4.	60.	110.	54.0	68.0	117.	122.	1.13	.880	MIX	.158-04
N2H4	221	UNLIKE-DOUBLET	.040	.040	4.	60.	110.	59.0	68.0	103.	110.	1.24	.810	MIX	.113-04
N2H4	222	UNLIKE-DOUBLET	.040	.040	4.	60.	110.	55.0	68.0	119.	114.	1.16	.860	MIX	.143-04
N2H4	223	UNLIKE-DOUBLET	.040	.040	4.	60.	110.	59.0	68.0	119.	114.	1.52	.800	UNDEF	.143-04
N2H4	231	UNLIKE-DOUBLET	.040	.040	4.	60.	350.	51.0	66.0	79.	67.	1.10	1.180	SEP	.373-05
N2H4	232	UNLIKE-DOUBLET	.040	.040	4.	60.	380.	55.0	66.0	85.	72.	1.18	1.000	SEP	.439-05
N2H4	234	UNLIKE-DOUBLET	.040	.040	4.	60.	353.	68.0	68.0	118.	118.	1.12	.880	SEP	.150-04
N2H4	235	UNLIKE-DOUBLET	.040	.040	4.	60.	353.	50.0	68.0	84.	103.	1.05	.950	SEP	.796-05
N2H4	236	UNLIKE-DOUBLET	.040	.040	4.	60.	346.	48.0	63.0	71.	90.	1.08	.920	SEP	.499-05
N2H4	237	UNLIKE-DOUBLET	.040	.040	4.	60.	362.	56.0	68.0	63.	93.	1.18	.840	SEP	.518-05
N2H4	238	UNLIKE-DOUBLET	.040	.040	4.	60.	361.	50.0	65.0	66.	85.	1.05	.950	SEP	.458-05
N2H4	239	UNLIKE-DOUBLET	.040	.040	4.	60.	145.	22.0	27.0	72.	82.	1.19	1.000	MIX	.182-05
N2H4	240	UNLIKE-DOUBLET	.040	.040	4.	60.	238.	65.0	68.0	63.	67.	1.37	.760	UNDEF	.317-05

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR ZUNG

FUEL TYPE	TEST NO.	MODE	PC (PSIA)	VAVG	WEF	WEO	REF	REO	DELTI (DEG F)	RELF	PELO	PPF (PSIA)	PPO (PSIA)	MRVP	XF	XO	XP	RESID
N2H4	184	MIX	119.	16.	.2	.8	.580+04	.213+05	0.	.23+05	.85+05	.7	27.5	118.2	.01	.23	.36-01	.24-03
N2H4	185	MIX	131.	17.	.3	1.0	.675+04	.228+05	0.	.27+05	.91+05	.6	36.2	175.0	.00	.28	.35-01	.20-03
N2H4	186	MIX	155.	23.	.8	1.7	.911+04	.246+05	0.	.36+05	.99+05	.5	17.7	104.2	.00	.11	.19-01	.14-03
N2H4	187	MIX	194.	27.	1.2	3.4	.102+05	.330+05	0.	.41+05	.13+06	.5	24.9	142.5	.00	.13	.18-01	.12-03
N2H4	188	MIX	194.	27.	1.4	3.1	.109+05	.308+05	0.	.44+05	.12+06	.5	22.1	132.1	.00	.11	.17-01	.11-03
N2H4	191	MIX	170.	25.	1.0	2.6	.105+05	.316+05	0.	.42+05	.13+06	.7	28.1	112.8	.00	.17	.27-01	.13-03
N2H4	192	MIX	152.	25.	1.0	2.3	.119+05	.318+05	0.	.48+05	.13+06	1.0	33.9	101.4	.01	.22	.36-01	.12-03
N2H4	193	MIX	174.	28.	1.5	2.7	.126+05	.312+05	0.	.51+05	.12+06	.6	26.8	122.7	.00	.15	.24-01	.11-03
N2H4	194	MIX	169.	27.	1.4	2.5	.126+05	.312+05	0.	.50+05	.12+06	.8	30.7	118.5	.00	.18	.26-01	.11-03
N2H4	196	MIX	194.	28.	1.8	2.5	.125+05	.267+05	0.	.50+05	.11+06	.6	17.3	93.3	.00	.09	.16-01	.10-03
N2H4	197	MIX	187.	25.	1.6	1.3	.107+05	.214+05	0.	.43+05	.86+05	.3	35.4	332.8	.00	.19	.17-01	.10-03
N2H4	198	MIX	164.	25.	1.1	2.3	.112+05	.293+05	0.	.45+05	.12+06	.7	24.9	107.8	.00	.15	.25-01	.12-03
N2H4	199	MIX	161.	27.	1.7	2.3	.138+05	.285+05	0.	.55+05	.11+06	.9	26.2	90.9	.00	.14	.26-01	.10-03
N2H4	200	MIX	203.	27.	1.8	2.3	.108+05	.240+05	0.	.43+05	.96+05	.3	12.9	127.9	.00	.06	.97-02	.10-03
N2H4	201	MIX	176.	26.	1.6	1.5	.108+05	.206+05	0.	.43+05	.82+05	.3	12.3	122.2	.00	.07	.11-01	.10-03
N2H4	204	MIX	110.	33.	1.2	2.1	.110+05	.304+05	0.	.44+05	.12+06	.2	9.2	135.1	.00	.08	.12-01	.93-04
N2H4	205	MIX	115.	34.	1.2	2.8	.125+05	.368+05	0.	.50+05	.15+06	.4	17.3	130.8	.00	.15	.22-01	.95-04
N2H4	206	MIX	115.	32.	.9	3.0	.118+05	.403+05	0.	.47+05	.16+06	.6	24.9	126.8	.00	.22	.33-01	.11-03
N2H4	207	MIX	110.	31.	1.2	2.5	.145+05	.395+05	0.	.58+05	.16+06	.8	38.6	133.9	.01	.35	.51-01	.98-04
N2H4	208	MIX	110.	34.	1.6	2.2	.172+05	.367+05	0.	.69+05	.15+06	.9	32.3	110.3	.01	.29	.46-01	.83-04
N2H4	209	MIX	110.	32.	1.2	2.4	.152+05	.386+05	0.	.61+05	.15+06	.9	34.7	111.7	.01	.32	.51-01	.95-04
N2H4	210	MIX	110.	33.	1.4	2.7	.161+05	.418+05	0.	.64+05	.17+06	.9	49.4	154.9	.01	.45	.61-01	.90-04
N2H4	211	MIX	110.	32.	1.2	2.9	.157+05	.433+05	0.	.63+05	.17+06	1.0	49.4	134.1	.01	.45	.65-01	.95-04
N2H4	212	MIX	110.	32.	1.3	2.9	.159+05	.433+05	0.	.64+05	.17+06	1.1	49.4	128.5	.01	.45	.67-01	.95-04
N2H4	215	MIX	110.	62.	4.7	9.2	.309+05	.756+05	0.	.12+06	.30+06	1.1	37.0	98.5	.01	.34	.58-01	.49-04
N2H4	217	MIX	110.	52.	4.6	8.4	.282+05	.694+05	0.	.11+06	.28+06	.7	26.2	113.0	.01	.24	.38-01	.49-04
N2H4	219	MIX	110.	59.	4.1	10.1	.292+05	.817+05	0.	.12+06	.33+06	1.2	51.8	124.9	.01	.47	.71-01	.53-04
N2H4	220	MIX	110.	61.	4.5	9.0	.317+05	.763+05	0.	.13+06	.31+06	1.2	45.4	107.4	.01	.41	.68-01	.49-04
N2H4	221	MIX	110.	63.	4.6	9.9	.296+05	.778+05	0.	.12+06	.31+06	.9	33.1	107.0	.01	.30	.50-01	.49-04
N2H4	222	MIX	110.	61.	4.7	9.5	.302+05	.765+05	0.	.12+06	.31+06	1.0	47.3	134.8	.01	.43	.63-01	.49-04
N2H4	223	[illegible]	110.	63.	4.7	10.9	.302+05	.842+05	0.	.12+06	.34+06	1.0	47.3	134.8	[illegible]	.43	.63-01	.49-04
N2H4	231	SEP	351.	58.	12.7	20.7	.206+05	.578+05	0.	.82+05	.23+06	.2	18.6	234.5	0	.05	.58-02	.51-04
N2H4	232	SEP	34[illegible].	60.	13.9	26.9	.214+05	.647+05	0.	.86+05	.26+06	.3	21.6	233.1	.00	.06	.62-02	.51-04
N2H4	23[illegible]	SEP	353.	66.	15.2	46.2	.309+05	.966+05	0.	.12+05	.39+06	1.1	46.3	121.1	.00	.13	.20-01	.49-04
N2H4	233	SEP	353.	59.	14.7	20.5	.265+05	.584+05	0.	.11+06	.23+06	.7	21.1	66.5	.00	.06	.11-01	.49-04
N2H4	[illegible]	SEP	[illegible]	55.	12.6	17.4	.237+05	.520+05	0.	.95+05	.21+06	.5	15.2	93.3	.00	.04	.78-02	.53-04
N2H4	237	SEP	3[illegible].	62.	14.7	23.8	.263+05	.580+05	0.	.11+06	.23+06	.5	12.6	[illegible].7	.00	.03	.72-02	.49-04
N2H4	23[illegible]	SEP	361.	59.	14.4	19.2	.245+05	.526+05	0.	.98+05	.21+06	.4	13.5	100.2	.00	.04	.65-02	.49-04
N2H4	23[illegible]	[illegible]	145.	24.	.9	1.5	.951+04	.239+05	0.	.38+05	.96+05	.4	15.6	129.6	.00	.11	.16-01	.12-03
N2H4	[illegible]	SEP	25[illegible].	66.	9.2	21.1	.212+05	[illegible]+05	0.	.85+05	.27+06	.2	12.6	164.1	.00	.05	.70-02	.49-04

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR ZUNG

FUEL TYPE	TEST NO.	INJECTOR TYPE	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	MODE	REACT (SEC)
N2H4	241	UNLIKE-DOUBLET	.040	.040	4.	60.	230.	74.0	68.0	115.	117.	1.56	.590	MIX	.144-04
N2H4	242	UNLIKE-DOUBLET	.040	.040	4.	60.	176.	55.0	69.0	146.	127.	1.14	1.110	MIX	.238-04
N2H4	243	UNLIKE-DOUBLET	.040	.040	4.	60.	176.	55.0	69.0	117.	122.	1.14	1.110	MIX	.161-04
N2H4	244	UNLIKE-DOUBLET	.040	.040	4.	60.	338.	34.0	65.0	44.	54.	.87	1.890	SEP	.180-05
N2H4	246	UNLIKE-DOUBLET	.040	.040	4.	60.	400.	57.0	61.0	39.	41.	1.31	.820	SEP	.116-05
N2H4	247	UNLIKE-DOUBLET	.040	.040	4.	60.	215.	58.0	66.0	51.	62.	1.25	.920	MIX	.233-05
N2H4	248	UNLIKE-DOUBLET	.040	.040	4.	60.	115.	61.0	65.0	51.	60.	1.34	.790	MIX	.219-05
N2H4	250	UNLIKE-DOUBLET	.040	.040	4.	60.	215.	61.0	68.0	58.	70.	1.29	.890	MIX	.313-05
N2H4	251	UNLIKE-DOUBLET	.040	.040	4.	60.	384.	56.0	65.0	62.	74.	1.23	.940	SEP	.337-05
N2H4	252	UNLIKE-DOUBLET	.040	.040	4.	60.	307.	45.0	50.0	65.	76.	1.28	.870	UNDEF	.277-05
N2H4	253	UNLIKE-DOUBLET	.040	.040	4.	60.	507.	35.0	38.0	68.	77.	1.29	.850	SEP	.221-05
N2H4	254	UNLIKE-DOUBLET	.040	.040	4.	60.	520.	36.0	28.0	77.	86.	1.33	.590	SEP	.221-05
N2H4	255	UNLIKE-DOUBLET	.040	.040	4.	60.	84.	49.0	52.0	106.	.03.	1.32	.820	MIX	.790-05
N2H4	256	UNLIKE-DOUBLET	.040	.040	4.	60.	100.	56.0	65.0	126.	120.	1.26	.920	MIX	.161-04
N2H4	257	UNLIKE-DOUBLET	.040	.040	4.	60.	122.	56.0	66.0	124.	120.	1.20	.980	MIX	.160-04
N2H4	258	UNLIKE-DOUBLET	.040	.040	4.	60.	423.	32.0	37.0	93.	104.	1.22	.950	SEP	.492-05
N2H4	259	UNLIKE-DOUBLET	.040	.040	4.	60.	461.	32.0	37.0	94.	99.	1.22	.840	SEP	.453-05
N2H4	260	UNLIKE-DOUBLET	.040	.040	4.	60.	461.	32.0	37.0	74.	84.	1.24	.920	SEP	.268-05
N2H4	261	UNLIKE-DOUBLET	.040	.040	4.	60.	115.	31.0	37.0	79.	88.	1.18	1.010	MIX	.311-05
N2H4	262	UNLIKE-DOUBLET	.040	.040	4.	60.	130.	34.0	41.0	92.	97.	1.18	1.040	MIX	.475-05
N2H4	263	UNLIKE-DOUBLET	.040	.040	4.	60.	149.	40.0	52.0	90.	97.	1.10	1.180	MIX	.586-05
N2H4	264	UNLIKE-DOUBLET	.040	.040	4.	60.	169.	46.0	53.0	90.	97.	1.24	.930	MIX	.598-05
N2H4	265	UNLIKE-DOUBLET	.040	.040	4.	60.	188.	51.0	61.0	84.	93.	1.17	1.030	MIX	.600-05
N2H4	266	UNLIKE-DOUBLET	.040	.040	4.	60.	203.	56.0	69.0	83.	93.	1.16	.860	MIX	.671-05
N2H4	267	UNLIKE-DOUBLET	.040	.040	4.	60.	388.	56.0	68.0	81.	88.	1.22	.950	SEP	.586-05
N2H4	268	UNLIKE-DOUBLET	.040	.040	4.	60.	381.	58.0	57.0	78.	86.	1.44	.680	SEP	.454-05
N2H4	269	UNLIKE-DOUBLET	.040	.040	4.	60.	353.	55.0	52.0	77.	86.	1.49	.670	SEP	.410-05
N2H4	270	UNLIKE-DOUBLET	.040	.040	4.	60.	176.	49.0	71.0	138.	129.	.97	1.520	MIX	.232-04
N2H4	272	UNLIKE-DOUBLET	.040	.040	4.	60.	179.	56.0	63.0	106.	111.	1.28	.870	MIX	.110-04
N2H4	273	UNLIKE-DOUBLET	.040	.040	4.	60.	176.	58.0	63.0	120.	124.	1.31	.820	MIX	.157-04
N2H4	274	UNLIKE-DOUBLET	.040	.040	4.	60.	176.	55.0	46.0	117.	120.	1.70	.490	MIX	.103-04
N2H4	275	UNLIKE-DOUBLET	.040	.040	4.	60.	138.	42.0	51.0	114.	117.	1.17	1.030	MIX	.106-04
N2H4	276	UNLIKE-DOUBLET	[illegible]	.040	4.	60.	279.	75.0	73.0	70.	70.	1.45	.680	UNDEF	.389-05
N2H4	278	UNLIKE-DOUBLET	.040	.040	4.	60.	237.	61.0	73.0	70.	70.	1.19	.980	MIX	.389-05
N2H4	279	UNLIKE-DOUBLET	.040	.040	4.	60.	250.	66.0	73.0	70.	70.	1.29	1.160	MIX	.389-05
N2H4	281	UNLIKE-DOUBLET	.040	.040	4.	60.	100.	101.0	127.0	69.	74.	1.13	1.120	MIX	.714-05
N2H4	282	UNLIKE-DOUBLET	.040	.040	4.	60.	115.	117.0	127.0	69.	73.	1.54	.370	MIX	.703-05
N2H4	283	UNLIKE-DOUBLET	.040	.040	4.	60.	326.	84.0	98.0	84.	98.	1.22	.940	SEP	.105-04
N2H4	284	UNLIKE-DOUBLET	.040	.040	4.	60.	282.	76.0	93.0	54.	74.	1.16	1.060	SEP	.431-05
N2H4	285	UNLIKE-DOUBLET	.040	.040	4.	60.	228.	63.0	78.0	54.	86.	1.16	1.060	MIX	.457-05

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OF POOR QUALITY

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR ZUNG

FUEL TYPE	TEST NO.	MODE	PC (PSIA)	VAVG	WEF	WEO	REF	REO	DELTI (DEG F)	RELF	RELO	PPF (PSIA)	PPO (PSIA)	MRVP	XF	XO	XP	RESID
N2H4	241	MIX	230.	72.	9.9	35.0	.308+05	.103+06	0.	.12+06	.41+06	1.1	43.4	116.6	.00	.19	.30-01	.49-04
N2H4	242	MIX	176.	62.	7.9	18.2	.331+05	.919+05	0.	.13+06	.37+06	1.4	84.3	166.2	.01	.48	.62-01	.48-04
N2H4	243	MIX	176.	62.	7.9	15.0	.321+05	.777+05	0.	.13+06	.31+06	1.2	45.4	107.4	.01	.26	.42-01	.48-04
N2H4	244	SEP	338.	53.	11.6	9.9	.184+05	.380+05	0.	.74+05	.15+06	.1	7.4	153.3	.00	.02	.30-02	.51-04
N2H4	246	SEP	400.	59.	11.8	24.4	.159+05	.558+05	0.	.64+05	.22+06	.1	6.4	232.9	.00	.02	.18-02	.55-04
N2H4	247	MIX	215.	62.	7.7	14.3	.198+05	.565+05	0.	.79+05	.23+06	.2	8.9	140.8	.00	.04	.60-02	.51-04
N2H4	248	MIX	115.	63.	4.0	8.5	.192+05	.594+05	0.	.77+05	.24+06	.2	8.9	152.7	.00	.08	.11-01	.51-04
N2H4	250	MIX	218.	64.	8.5	16.6	.217+05	.616+05	0.	.87+05	.25+06	.2	11.0	132.6	.00	.05	.75-02	.49-04
N2H4	251	SEP	384.	60.	13.7	25.1	.214+05	.577+05	0.	.86+05	.23+06	.3	12.3	131.5	.00	.03	.48-02	.51-04
N2H4	252	UNDEF	307.	47.	6.5	13.2	.168+05	.471+05	0.	.67+05	.19+06	.3	13.2	133.9	.00	.04	.64-02	.67-04
N2H4	253	SEP	507.	36.	6.2	13.3	.128+05	.373+05	0.	.51+05	.15+06	.3	14.2	139.2	.00	.03	.40-02	.88-04
N2H4	254	SEP	520.	33.	3.5	15.1	.102+05	.403+05	0.	.41+05	.16+06	.4	17.7	123.6	.00	.03	.52-02	.12-03
N2H4	255	MIX	84.	50.	2.0	5.3	.218+05	.655+05	0.	.87+05	.26+06	.7	35.4	139.8	.01	.42	.60-01	.64-04
N2H4	256	MIX	100.	60.	3.9	9.3	.299+05	.830+05	0.	.12+06	.33+06	1.2	55.3	136.8	.01	.55	.80-01	.51-04
N2H4	257	MIX	122.	61.	5.0	11.2	.304+05	.82[illegible]+05	0.	.12+06	.33+06	1.2	52.9	13[illegible].4	.01	.43	.64-01	.51-04
N2H4	258	SEP	423.	34.	5.2	10.6	.156+05	.395+05	0.	.62+05	.16+06	.8	26.2	102.3	.00	.06	.10-01	.90-04
N2H4	259	SEP	461.	34.	5.6	11.6	.151+05	.399+05	0.	.60+05	.16+06	.6	26.8	122.7	.00	.06	.89-02	.90-04
N2H4	260	SEP	461.	34.	5.4	10.4	.132+05	.352+05	0.	.53+05	.14+06	.4	16.5	124.9	.00	.04	.55-02	.90-04
N2H4	261	MIX	115.	34.	1.4	2.5	.137+05	.351+05	0.	.55+05	.14+06	.5	18.6	120.0	.00	.16	.25-01	.90-04
N2H4	262	MIX	130.	37.	1.9	3.7	.164+05	.418+05	0.	.66+05	.17+06	.6	25.5	123.2	.00	.20	.30-01	.81-04
N2H4	263	MIX	14[illegible].	46.	3.6	5.7	.208+05	.486+05	0.	.83+05	.19+06	.6	24.2	117.4	.00	.16	.26-01	.64-04
N2H4	264	MIX	169.	49.	4.2	8.6	.212+05	.559+05	0.	.85+05	.22+06	.6	24.2	117.4	.00	.14	.23-01	.63-04
N2H4	265	MIX	188.	56.	6.2	11.4	.236+05	.596+05	0.	.94+05	.24+06	.5	21.1	115.2	.00	.11	.18-01	.55-04
N2H4	266	MIX	203.	62.	8.5	14.7	.267+05	.650+05	0.	.11+06	.26+06	.5	20.5	112.6	.00	.10	.16-01	.48-04
N2H4	267	SEP	308.	63.	15.[illegible]	29.9	.252+05	.66[illegible]+05	0.	.10+06	.27+06	.5	19.5	125.	.00	.05	.77-02	.49-04
N2H4	268	SEP	391.	58.	10.7	28.9	.207+05	.654+05	0.	.83+05	.26+06	.4	18.1	126.3	.00	.05	.72-02	.58-04
N2H4	269	SEP	353.	54.	8.3	24.0	.189+05	.616+05	0.	.76+05	.25+06	.4	17.7	123.6	.00	.05	.77-02	.64-04
N2H4	270	MIX	176.	60.	8.4	13.7	.345+05	.778+05	0.	.14+06	.31+06	1.5	71.3	135.7	.01	.41	.59-01	.47-04
N2H4	272	MIX	179.	59.	6.5	14.8	.275+05	.749+05	0.	.11+06	.30+06	.9	35.4	111.1	.01	.20	.32-01	.53-04
N2H4	273	MIX	176.	60.	6.6	17.0	.297+05	.6[illegible]2+05	0.	.12+06	.33+06	1.3	48.2	107.4	.01	.27	.45-01	.53-04
N2H4	274	MIX	176.	52.	3.[illegible]	15.0	.212+05	.77[illegible]+05	0.	.85+05	.31+06	1.2	45.4	114.0	.01	.26	.41-01	.72-04
N2H4	275	MIX	138.	46.	3.5	6.7	.231+05	.584+05	0.	.92+05	.23+06	1.1	42.5	114.2	.01	.31	.49-01	.65-04
N2H4	276	[illegible]	279.	74.	12.5	34.0	.233+05	.807+05	0.	.93+05	.32+06	.2	14.8	173.4	.00	.05	.68-02	.46-04
N2H4	27[illegible]	MIX	237.	69.	10.6	19.1	.233+05	.657+05	0.	.93+05	.26+06	.2	14.8	173.4	.00	.06	.80-02	.46-04
N2H4	27[illegible]	MIX	250.	69.	11.2	23.6	.233+05	.710+05	0.	.93-05	.28+06	.2	14.8	173.4	.00	.06	.76-02	.46-04
N2H4	281	MIX	100.	113.	13.6	22.0	.419+05	.108+06	0.	.17+06	.43+06	.3	14.5	152.7	.00	.14	.20-01	.26-04
N2H4	282	MIX	115.	121.	15.7	34.0	.415+05	.125+06	0.	.17+06	.50+06	.3	14.5	156.7	.00	.13	.17-01	.26-04
N2H4	283	SEP	326.	90.	27.[illegible]	53.6	.396+05	.982+05	0.	.16+06	.39+06	.6	21.1	100.7	.00	.06	.11-01	.34-04
N2H4	284	SEP	262.	8[illegible].	2[illegible].6	3[illegible].7	.307+05	.752+05	0.	.12+06	.30+06	.3	9.8	106.5	.00	.03	.58-02	.36-04
N2H4	285	MIX	228.	70.	12.[illegible]	18.2	.284+05	.623+05	0.	.11+06	.25+06	.4	9.8	71.5	.00	.04	.89-02	.43-04

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HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR ZUNG

FUEL TYPE	TEST NO.	INJECTOR TYPE	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	MODE	REACT (SEC)
N2H4	286	UNLIKE-DOUBLET	.040	.040	4.	60.	192.	1.0	63.0	54.	86.	1.14	1.060	MIX	.369-05
N2H4	287	UNLIKE-DOUBLET	.040	.040	4.	60.	182.	44.0	51.0	55.	86.	1.25	.920	MIX	.303-05
N2H4	288	UNLIKE-DOUBLET	.040	.040	4.	60.	186.	46.0	52.0	62.	57.	1.89	.600	MIX	.196-05
N2H4	289	UNLIKE-DOUBLET	.040	.040	4.	60.	174.	49.0	53.0	62.	55.	1.32	.820	MIX	.193-05
N2H4	290	UNLIKE-DOUBLET	.040	.040	4.	60.	186.	54.0	56.0	96.	101.	1.03	.780	MIX	.727-05
N2H4	291	UNLIKE-DOUBLET	.040	.040	4.	60.	162.	44.0	54.0	106.	71.	1.13	1.090	MIX	.453-05
N2H4	293	UNLIKE-DOUBLET	.060	.060	4.	60.	362.	92.0	121.0	60.	62.	1.09	1.200	SEP	.110-04
N2H4	294	UNLIKE-DOUBLET	.060	.060	4.	60.	180.	46.0	54.0	60.	64.	1.24	.940	MIX	.513-05
N2H4	295	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	64.0	73.0	59.	53.	1.44	.780	POP	.554-05
N2H4	296	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	49.0	61.0	57.	54.	1.15	1.090	POP	.459-05
N2H4	297	UNLIKE-DOUBLET	.060	.060	4.	60.	68.	49.0	61.0	57.	55.	1.23	1.010	POP	.467-05
N2H4	298	UNLIKE-DOUBLET	.040	.040	4.	60.	76.	46.0	53.0	52.	41.	1.20	.960	MIX	.120-05
N2H4	299	UNLIKE-DOUBLET	.040	.040	4.	60.	106.	36.0	53.0	53.	40.	.93	1.590	MIX	.118-05
N2H4	300	UNLIKE-DOUBLET	.040	.040	4.	60.	122.	46.0	37.0	53.	41.	1.11	1.050	MIX	.851-06
N2H4	301	UNLIKE-DOUBLET	.040	.040	4.	60.	100.	47.0	57.0	53.	41.	1.16	1.050	MIX	.131-05
N2H4	302	UNLIKE-DOUBLET	.040	040	4.	60.	192.	36.0	57.0	55.	43.	1.07	1.740	MIX	.144-05
N2H4	304	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	29.0	42.0	37.	37.	1.04	1.410	POP	.742-06
N2H4	305	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	13.0	16.0	43.	42.	1.00	1.270	MIX	.331-06
N2H4	306	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	16.0	16.0	39.	44.	1.26	.800	POP	.331-06
N2H4	307	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	52.0	49.0	32.	32.	1.58	.590	MIX	.786-06
N2H4	308	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	49.0	55.0	58.	59.	1.30	.860	POP	.203-05
N2H4	309	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	58.0	66.0	58.	59.	1.25	.860	POP	.244-05
N2H4	310	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	58.0	68.0	70.	78.	1.25	1.170	MIX	.410-05
N2H4	311	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	58.0	68.0	60.	66.	1.25	1.170	MIX	.299-05
N2H4	312	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	64.0	68.0	66.	61.	1.25	.800	MIX	.290-05
N2H4	313	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	64.0	68.0	53.	55.	1.25	.800	MIX	.218-05
N2H4	314	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	63.0	68.0	53.	55.	1.29	.800	MIX	.218-05
N2H4	316	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	63.0	63.0	48.	51.	1.44	.700	MIX	.173-05
N2H4	317	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	54.0	55.0	45.	51.	1.45	.710	POP	.146-05
N2H4	318	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	23.0	28.0	48.	51.	1.15	1.090	SEP	.770-06
N2H4	319	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	27.0	28.0	45.	51.	1.36	.770	SEP	.742-06
N2H4	320	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	18.0	19.0	55.	55.	1.40	.760	POP	.628-06
N2H4	321	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	18.0	17.0	57.	59.	1.40	.760	POP	.695-06
N2H4	322	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	18.0	19.0	58.	61.	1.29	.820	MIX	.731-06
N2H4	323	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	19.0	19.0	50.	51.	1.46	.700	POP	.534-06
N2H4	324	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	18.0	18.0	50.	51.	1.57	.620	SEP	.506-06
N2H4	325	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	23.0	24.0	63.	72.	1.37	.780	SEP	.122-05
N2H4	326	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	22.0	24.0	58.	51.	1.30	.850	POP	.173-05
N2H4	327	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	21.0	23.0	48.	48.	1.30	.840	POP	.133-05
N2H4	328	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	22.0	24.0	47.	55.	1.31	.830	POP	.156-05

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR ZUNG

FUEL TYPE	TEST NO.	MODE	PC (PSIA)	VAVG.	WEF	WEO	REF	REO	DELTI (DEG F)	RELF	RELO	PPF (PSIA)	PPU (PSIA)	MRVP	XF	XU	XP	RESID
N2H4	286	MIX	192.	57.	6.6	10.0	.229+05	.504+05	0.	.92+05	.20+06	.4	9.8	71.5	.00	.05	.11-01	.53-04
N2H4	287	MIX	182.	47.	4.1	7.1	.186+05	.437+05	0.	.74+05	.17+06	.4	10.1	73.6	.00	.06	.11-01	.65-04
N2H4	288	MIX	186.	48.	4.1	8.2	.151+05	.474+05	0.	.60+05	.19+06	.2	12.3	224.7	.00	.07	.74-02	.64-04
N2H4	289	MIX	174.	51.	4.0	8.7	.151+05	.505+05	0.	.61+05	.20+06	.1	12.3	238.4	.00	.07	.77-02	.63-04
N2H4	290	MIX	186.	55.	5.2	13.5	.232+05	.683+05	0.	.93+05	.27+06	.7	28.1	120.8	.00	.15	.23-01	.60-04
N2H4	291	MIX	162.	49.	4.0	8.2	.174+05	.588+05	0.	.69+05	.24+06	.3	35.4	378.7	.00	.22	.18-01	.62-04
N2H4	293	SEP	362.	106.	65.7	95.0	.545+05	.141+06	0.	.22+06	.56+06	.2	11.7	182.1	.00	.03	.41-02	.41-04
N2H4	294	MIX	180.	50.	6.5	11.8	.247+05	.704+05	0.	.99+05	.28+06	.2	11.7	169.0	.00	.06	.85-02	.93-04
N2H4	295	POP	15.	68.	1.0	1.9	.308+05	.974+05	0.	.12+06	.39+06	.1	11.4	236.0	.01	.77	.85-01	.68-04
N2H4	296	POP	15.	55.	.7	1.1	.259+05	.738+05	0.	.10+06	.30+06	.1	10.7	216.9	.01	.73	.84-01	.82-04
N2H4	297	POP	66.	54.	3.1	5.0	.261+05	.738+05	0.	.10+06	.30+06	.1	10.7	210.3	.00	.16	.18-01	.82-04
N2H4	298	MIX	76.	49.	1.7	3.2	.138+05	.450+05	0.	.55+05	.18+06	.1	9.2	323.9	.00	.12	.11-01	.63-04
N2H4	299	MIX	106.	45.	2.4	2.7	.137+05	.354+05	0.	.55+05	.14+06	.1	9.5	354.7	.00	.09	.80-02	.63-04
N2H4	300	MIX	122.	42.	1.3	5.2	.963+04	.453+05	0.	.39+05	.18+06	.1	9.5	334.2	.00	.08	.71-02	.90-04
N2H4	301	MIX	100.	52.	2.6	4.4	.148+05	.463+05	0.	.59+05	.19+06	.1	9.5	334.2	.00	.09	.87-02	.58-04
N2H4	302	MIX	192.	46.	5.0	5.0	.150+05	.358+05	0.	.60+05	.14+06	.1	10.1	318.2	.00	.05	.49-02	.56-04
N2H4	304	POP	15.	35.	.2	.2	.109+05	.284+05	0.	.44+05	.11+06	.1	6.0	231.8	.01	.41	.46-01	.79-04
N2H4	305	MIX	15.	14.	.0	.0	.419+04	.127+05	0.	.17+05	.51+05	.1	7.2	244.7	.01	.49	.53-01	.21-03
N2H4	306	POP	15.	16.	.0	.1	.425+04	.157+05	0.	.17+05	.63+05	.1	6.4	198.7	.01	.44	.53-01	.21-03
N2H4	307	MIX	15.	51.	.3	.7	.127+05	.512+05	0.	.51+05	.20+06	.1	5.1	194.7	.01	.35	.42-01	.68-04
N2H4	308	SEP	15.	52.	.4	.7	.162+05	.495+05	0.	.65+05	.20+06	.2	11.0	192.6	.01	.75	.92-01	.61-04
N2H4	309	SEP	15.	62.	.5	1.0	.194+05	.585+05	0.	.78+05	.23+06	.2	11.0	192.6	.01	.75	.92-01	.51-04
N2H4	310	MIX	15.	62.	.6	1.1	.232+05	.624+05	0.	.93+05	.25+06	.3	14.8	141.4	.02	1.01	.14+00	.49-04
N2H4	311	MIX	15.	62.	.6	1.0	.210+05	.591+05	0.	.84+05	.24+06	.2	11.7	157.9	.01	.79	.11+00	.49-04
N2H4	312	MIX	15.	66.	.6	1.3	.203+05	.674+05	0.	.81+05	.27+06	.2	13.5	217.2	.01	.92	.11+00	.49-04
N2H4	313	MIX	15.	66.	.6	1.2	.194+05	.630+05	0.	.78+05	.25+06	.1	9.5	187.3	.01	.65	.80-01	.49-04
N2H4	314	MIX	15.	65.	.6	1.2	.194+05	.620+05	0.	.78+05	.25+06	.1	9.5	187.3	.01	.65	.80-01	.49-04
N2H4	316	MIX	15.	63.	.5	1.1	.175+05	.612+05	0.	.70+05	.24+06	.1	8.2	185.8	.01	.56	.69-01	.53-04
N2H4	317	POP	15.	54.	.4	.8	.153+05	.526+05	0.	.61+05	.21+06	.1	7.6	173.6	.01	.52	.67-01	.61-04
N2H4	318	SEP	15.	25.	.1	.2	.778+04	.223+05	0.	.31+05	.89+05	.1	8.2	185.8	.01	.56	.69-01	.12-03
N2H4	319	SEP	15.	27.	.1	.2	.778+04	.263+05	0.	.31+05	.11+06	.1	7.6	173.6	.01	.52	.67-01	.12-03
N2H4	320	POP	15.	18.	.0	.1	.543+04	.179+05	0.	.22+05	.72+05	.1	10.1	198.8	.01	.69	.83-01	.18-03
N2H4	321	POP	15.	18.	.0	.1	.558+04	.181+05	0.	.22+05	.72+05	.2	10.7	187.5	.01	.73	.91-01	.18-03
N2H4	322	MIX	15.	18.	.0	.1	.566+04	.182+05	0.	.23+05	.73+05	.2	11.0	180.0	.01	.75	.95-01	.18-03
N2H4	323	POP	15.	19.	.0	.1	.528+04	.184+05	0.	.21+05	.74+05	.1	8.6	193.8	.01	.58	.71-01	.18-03
N2H4	324	SEP	15.	18.	.0	.1	.500+04	.175+05	0.	.20+05	.70+05	.1	8.6	193.8	.01	.58	.71-01	.19-03
N2H4	325	SEP	15.	23.	.1	.2	.778+04	.238+05	0.	.31+05	.95+05	.3	12.6	141.8	.02	.86	.12+00	.14-03
N2H4	326	POP	15.	23.	.1	.2	.100+05	.333+05	0.	.40+05	.13+06	.1	11.0	246.2	.01	.75	.81-01	.21-03
N2H4	327	POP	15.	22.	.1	.2	.940+04	.306+05	0.	.38+05	.12+06	.1	8.2	207.9	.01	.56	.65-01	.22-03
N2H4	328	POP	15.	[illegible]	.1	.2	.103+05	.321+05	0.	.41+05	.13+06	.1	8.0	159.3	.01	.54	.73-01	.21-03

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HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR ZUNG

FUEL TYPE	TEST NO.	INJECTOR TYPE	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	MODE	REACT (SEC)
N2H4	329	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	21.0	24.0	47.	53.	1.27	.900	PUP	.153-05
N2H4	330	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	21.0	24.0	48.	53.	1.27	.900	PUP	.154-05
N2H4	331	UNLIKE-DOUBLET	.060	.060	4.	60.	15.	27.0	31.0	64.	61.	1.24	.920	PUP	.290-05
N2H4	332	UNLIKE-DOUBLET	.060	.060	4.	60.	75.	34.0	43.0	63.	64.	1.11	1.160	PUP	.425-05
N2H4	333	UNLIKE-DOUBLET	.060	.060	4.	60.	80.	40.0	50.0	63.	64.	1.13	1.120	POP	.494-05
N2H4	334	UNLIKE-DOUBLET	.060	.060	4.	60.	95.	34.0	57.0	61.	53.	.82	2.080	POP	.537-05
N2H4	335	UNLIKE-DOUBLET	.060	.060	4.	60.	96.	26.0	31.0	64.	61.	1.23	1.570	PUP	.290-05
N2H4	336	UNLIKE-DOUBLET	.060	.060	4.	60.	70.	34.0	44.0	63.	64.	1.11	1.150	POP	.434-05
N2H4	337	UNLIKE-DOUBLET	.060	.060	4.	60.	80.	36.0	57.0	61.	66.	.89	1.780	PUP	.571-05
N2H4	338	UNLIKE-DOUBLET	.060	.060	4.	60.	85.	43.0	50.0	86.	89.	1.24	.940	POP	.105-04
N2H4	339	UNLIKE-DOUBLET	.060	.060	4.	60.	125.	45.0	58.0	108.	97.	1.11	1.160	POP	.182-04
N2H4	340	UNLIKE-DOUBLET	.060	.060	4.	60.	75.	36.0	50.0	108.	117.	1.05	1.310	POP	.219-04
N2H4	341	UNLIKE-DOUBLET	.060	.060	4.	60.	75.	41.0	50.0	100.	107.	1.16	1.060	POP	.171-04
N2H4	342	UNLIKE-DOUBLET	.060	.060	4.	60.	145.	42.0	50.0	99.	107.	1.21	.990	PUP	.169-04
N2H4	343	UNLIKE-DOUBLET	.060	.060	4.	60.	145.	41.0	50.0	103.	118.	1.16	1.060	PUP	.210-04
N2H4	344	UNLIKE-DOUBLET	.060	.060	4.	60.	145.	43.0	50.0	80.	81.	1.24	.810	PUP	.813-05
N2H4	345	UNLIKE-DOUBLET	.060	.060	4.	60.	165.	43.0	49.0	78.	81.	1.26	.900	POP	.779-05
N2H4	346	UNLIKE-DOUBLET	.060	.060	4.	60.	165.	45.0	50.0	76.	76.	1.28	.880	PUP	.714-05
N2H4	347	UNLIKE-DOUBLET	.060	.060	4.	60.	165.	44.0	49.0	78.	80.	1.25	.920	POP	.758-05
N2H4	348	UNLIKE-DOUBLET	.060	.060	4.	60.	165.	32.0	50.0	83.	83.	.91	1.720	POP	.890-05
N2H4	349	UNLIKE-DOUBLET	.060	.060	4.	60.	165.	33.0	51.0	90.	91.	.93	1.640	PUP	.117-04
N2H4	350	UNLIKE-DOUBLET	.060	.060	4.	60.	185.	40.0	51.0	94.	91.	1.12	1.130	PUP	.123-04
N2H4	351	UNLIKE-DOUBLET	.060	.060	4.	60.	185.	47.0	50.0	70.	72.	1.35	7.820	POP	.619-05
N2H4	352	UNLIKE-DOUBLET	.060	.060	4.	60.	165.	41.0	49.0	68.	72.	1.21	.980	UNDEF	.594-05
N2H4	353	UNLIKE-DOUBLET	.060	.060	4.	60.	165.	42.0	49.0	66.	70.	1.23	.938	PUP	.562-05
N2H4	354	UNLIKE-DOUBLET	.060	.060	4.	60.	165.	42.0	51.0	50.	49.	1.19	1.020	PUP	.309-05
N2H4	355	UNLIKE-DOUBLET	.060	.060	4.	60.	175.	44.0	51.0	47.	47.	1.23	.930	UNDEF	.265-05
N2H4	356	UNLIKE-DOUBLET	.060	.060	4.	60.	165.	36.0	51.0	50.	49.	1.03	1.350	POP	.309-05
N2H4	357	UNLIKE-DOUBLET	.060	.060	4.	60.	165.	41.0	49.0	50.	51.	1.21	.970	PUP	.310-05
N2H4	358	UNLIKE-DOUBLET	.060	.060	4.	60.	165.	42.0	51.0	50.	51.	1.19	1.020	PUP	.323-05
N2H4	359	UNLIKE-DOUBLET	.060	.060	4.	60.	165.	42.0	51.0	48.	47.	1.19	1.020	PUP	.289-05
N2H4	360	UNLIKE-DOUBLET	.060	.060	4.	60.	165.	33.0	60.0	57.	53.	.08	1.020	POP	.443-05
N2H4	361	UNLIKE-DOUBLET	.060	.060	4.	60.	165.	42.0	51.0	55.	55.	1.02	1.190	POP	.379-05
N2H4	362	UNLIKE-DOUBLET	.060	.060	4.	60.	105.	40.0	52.0	55.	53.	1.12	1.140	PUP	.372-05
N2H4	363	UNLIKE-DOUBLET	.060	.060	4.	60.	105.	44.0	51.0	53.	53.	1.23	.930	PUP	.354-05
N2H4	364	UNLIKE-DOUBLET	.060	.060	4.	60.	105.	44.0	52.0	60.	63.	1.23	.950	POP	.484-05
N2H4	365	UNLIKE-DOUBLET	.060	.060	4.	60.	105.	43.0	51.0	60.	63.	1.22	.960	POP	.474-05
N2H4	366	UNLIKE-DOUBLET	.060	.060	4.	60.	105.	45.0	52.0	60.	63.	1.25	.920	POP	.484-05
N2H4	367	UNLIKE-DOUBLET	.060	.060	4.	60.	105.	45.0	52.0	76.	80.	1.25	.930	POP	.786-05
N2H4	368	UNLIKE-DOUBLET	.060	.060	4.	60.	185.	45.0	49.0	68.	70.	1.29	.850	PUP	.574-05

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR ZUNG

FUEL TYPE	TEST NO.	MODE	PC (PSIA)	VAVG	WEF	WEO	REF	REO	DELT (DEG F)	RELF	RELO	PPF (PSIA)	PPO (PSIA)	MRVP	XF	XO	XP	RESID
N2H4	329	POP	15.	22.	.1	.2	.101+05	.306+05	0.	.41+05	.12+06	.1	8.0	169.8	.01	.54	.71-01	.21-03
N2H4	330	POP	15.	22.	.1	.2	.101+05	.306+05	0.	.41+05	.12+06	.1	8.2	173.5	.01	.56	.72-01	.21-03
N2H4	331	POP	15.	29.	.2	.3	.139+05	.422+05	0.	.55+05	.17+06	.2	12.9	208.0	.01	.88	.10+00	.16-03
N2H4	332	POP	75.	38.	1.7	2.7	.197+05	.528+05	0.	.79+05	.21+06	.2	12.6	181.5	.00	.17	.21-01	.12-03
N2H4	333	PUP	80.	45.	2.5	4.0	.229+05	.622+05	0.	.91+05	.25+06	.2	12.6	181.5	.00	.16	.20-01	.10-03
N2H4	334	PUP	95.	47.	3.8	3.4	.259+05	.523+05	0.	.10+06	.21+06	.2	12.0	179.6	.00	.13	.16-01	.88-04
N2H4	335	PCP	96.	28.	1.1	2.0	.139+05	.406+05	0.	.55+05	.16+06	.2	12.9	208.0	.00	.13	.16-01	.16-03
N2H4	336	PUP	70.	39.	1.7	2.5	.201+05	.528+05	0.	.80+05	.21+06	.2	12.6	181.5	.00	.18	.23-01	.11-03
N2H4	337	POP	80.	47.	3.2	3.2	.265+05	.554+05	0.	.11+06	.22+06	.2	12.0	161.7	.00	.15	.20-01	.88-04
N2H4	338	POP	85.	46.	2.8	5.5	.280+05	.763+05	0.	.11+06	.31+06	.5	22.1	136.5	.01	.26	.38-01	.10-03
N2H4	339	POP	125.	51.	5.6	10.1	.348+05	.911+05	0.	.14+06	.36+06	.6	37.0	173.9	.00	.30	.38-01	.86-04
N2H4	340	PUP	75.	43.	2.6	3.9	.339+05	.729+05	0.	.14+06	.29+06	1.1	37.0	100.6	.01	.49	.84-01	.10-03
N2H4	341	PUP	75.	45.	2.5	4.8	.321+05	.799+05	0.	.13+06	.32+06	.8	30.7	108.3	.01	.41	.67-01	.10-03
N2H4	342	PUP	145.	46.	4.9	9.7	.321+05	.813+05	0.	.13+06	.33+06	.8	30.0	106.2	.01	.21	.34-01	.10-03
N2H4	343	POP	145.	45.	5.0	9.4	.341+05	.811+05	0.	.14+06	.32+06	1.1	33.1	88.7	.01	.23	.42-01	.10-03
N2H4	344	POP	145.	46.	4.7	9.2	.262+05	.736+05	0.	.10+06	.29+06	.3	19.0	162.5	.00	.13	.17-01	.10-03
N2H4	345	POP	165.	46.	5.1	10.3	.257+05	.727+05	0.	.10+06	.29+06	.3	18.1	155.8	.00	.11	.15-01	.10-03
N2H4	346	PUP	165.	47.	5.3	11.2	.251+05	.752+05	0.	.10+06	.30+06	.3	17.3	171.5	.00	.10	.14-01	.10-03
N2H4	347	POP	165.	46.	5.1	10.8	.255+05	.744+05	0.	.10+06	.30+06	.3	18.1	163.6	.00	.11	.15-01	.10-03
N2H4	348	POP	165.	41.	5.3	5.9	.266+05	.558+05	0.	.11+06	.22+06	.4	20.5	159.9	.00	.12	.17-01	.10-03
N2H4	349	PUP	165.	42.	5.6	6.5	.290+05	.601+05	0.	.12+06	.24+06	.5	24.2	139.0	.00	.15	.21-01	.98-04
N2H4	350	POP	185.	45.	6.3	10.9	.290+05	.748+05	0.	.12+06	.30+06	.5	26.8	152.8	.00	.14	.20-01	.98-04
N2H4	351	PUP	185.	48.	5.8	13.3	.243+05	.759+05	0.	.97+05	.30+06	.3	14.8	164.0	.00	.08	.11-01	.10-03
N2H4	352	UNDEF	165.	45.	5.0	8.9	.238+05	.655+05	0.	.95+05	.26+06	.3	14.2	157.7	.00	.09	.12-01	.10-03
N2H4	353	PUP	165.	45.	5.0	9.3	.235+05	.663+05	0.	.94+05	.27+06	.2	13.5	160.0	.00	.08	.11-01	.10-03
N2H4	354	PUP	165.	46.	5.2	6.6	.210+05	.611+05	0.	.84+05	.24+06	.1	8.6	208.6	.00	.05	.61-02	.98-04
N2H4	355	UNDEF	175.	47.	5.5	9.9	.207+05	.642+05	0.	.83+05	.26+06	.1	8.0	211.9	.00	.05	.53-02	.98-04
N2H4	356	POP	165.	43.	5.2	6.3	.210+05	.524+05	0.	.84+05	.21+06	.1	8.6	208.6	.00	.05	.61-02	.98-04
N2H4	357	[illegible]	165.	45.	4.8	8.2	.204+05	.596+05	0.	.82+05	.24+06	.1	8.6	193.8	.00	.05	.63-02	.10-03
N2H4	358	[illegible]	165.	46.	5.2	6.6	.213+05	.611+05	0.	.85+05	.24+06	.1	8.6	193.8	.00	.05	.63-02	.98-04
N2H4	359	[illegible]	165.	45.	5.2	8.5	.207+05	.612+05	0.	.83+05	.24+06	.1	8.2	216.6	.00	.05	.57-02	.98-04
N2H4	360	[illegible]	165.	58.	7.2	5.5	.253+05	.497+05	0.	.10+06	.20+06	.1	10.7	224.0	.00	.07	.73-02	.83-04
N2H4	361	[illegible]	165.	46.	5.2	6.8	.218+05	.626+05	0.	.87+05	.25+06	.1	10.1	198.8	.00	.06	.74-02	.98-04
N2H4	362	[illegible]	105.	46.	3.5	5.1	.220+05	.596+05	0.	.88+05	.24+06	.1	10.1	211.8	.00	.10	.11-01	.96-04
N2H4	363	[illegible]	125.	47.	3.3	6.1	.215+05	.650+05	0.	.86+05	.26+06	.1	9.5	199.6	.00	.09	.11-01	.98-04
N2H4	364	[illegible]	105.	48.	3.5	6.3	.236+05	.673+05	0.	.94+05	.27+06	.2	11.7	175.3	.00	.11	.14-01	.96-04
N2H4	365	[illegible]	105.	47.	3.4	6.0	.231+05	.658+05	0.	.93+05	.26+06	.2	11.7	175.3	.00	.11	.14-01	.98-04
N2H4	366	PUP	105.	46.	3.5	6.6	.236+05	.688+05	0.	.94+05	.28+06	.2	11.7	175.3	.00	.11	.14-01	.96-04
N2H4	367	[illegible]	195.	48.	3.6	7.1	.270+05	.752+05	0.	.11+06	.30+06	.3	17.3	156.6	.00	.16	.22-01	.96-04
N2H4	368	[illegible]	185.	47.	5.6	12.1	.235+05	.718+05	0.	.94+05	.29+06	.2	14.2	166.8	.00	.08	.10-01	.10-03

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HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR ZUNG

FUEL TYPE	TEST NO.	INJECTOR TYPE	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	MODE	REACT (SEC)
N2H4	369	UNLIKE-DOUBLET	.060	.060	4.	60.	185.	43.0	50.0	70.	69.	1.24	.930	PUP	.588-05
N2H4	370	UNLIKE-DOUBLET	.060	.060	4.	60.	185.	41.0	49.0	65.	64.	1.21	.980	POP	.496-05
N2H4	371	UNLIKE-DOUBLET	.060	.060	4.	60.	185.	37.0	49.0	63.	63.	1.06	1.230	POP	.474-05
N2H4	372	UNLIKE-DOUBLET	.060	.060	4.	60.	185.	34.0	49.0	55.	55.	.98	1.450	PUP	.364-05
N2H4	373	UNLIKE-DOUBLET	.055	.055	4.	60.	95.	52.0	60.0	63.	64.	1.23	1.030	POP	.498-05
N2H4	374	UNLIKE-DOUBLET	.055	.055	4.	60.	95.	51.0	60.0	63.	64.	1.19	.990	PUP	.498-05
N2H4	375	UNLIKE-DOUBLET	.055	.055	4.	60.	95.	54.0	60.0	63.	64.	1.27	.790	PUP	.498-05
N2H4	376	UNLIKE-DOUBLET	.055	.055	4.	60.	165.	54.0	60.0	63.	64.	1.29	.850	PUP	.498-05
N2H4	377	UNLIKE-DOUBLET	.055	.055	4.	60.	175.	54.0	60.0	65.	82.	1.27	.880	POP	.703-05
N2H4	378	UNLIKE-DOUBLET	.055	.055	4.	60.	175.	56.0	61.0	66.	89.	1.31	.830	POP	.864-05
N2H4	379	UNLIKE-DOUBLET	.055	.055	4.	60.	175.	55.0	[illegible]	104.	82.	1.29	.860	PUP	.114-04
N2H4	380	UNLIKE-DOUBLET	.055	.055	4.	60.	175.	53.0	61.0	114.	105.	1.24	.930	PUP	.199-04
N2H4	381	UNLIKE-DOUBLET	.055	.055	4.	60.	175.	54.0	61.0	114.	107.	1.27	.880	POP	.206-04
N2H4	382	UNLIKE-DOUBLET	.055	.055	4.	60.	175.	52.0	61.0	111.	110.	1.21	1.080	PUP	.209-04
N2H4	383	UNLIKE-DOUBLET	.055	.055	4.	60.	175.	56.0	60.0	65.	66.	1.32	.810	PUP	.531-05
N2H4	384	UNLIKE-DOUBLET	.055	.055	4.	60.	175.	55.0	60.0	88.	78.	1.29	.990	POP	.857-05
N2H4	385	UNLIKE-DOUBLET	.055	.055	4.	60.	175.	53.0	60.0	76.	78.	1.26	.910	POP	.741-05
N2H4	388	UNLIKE-DOUBLET	.055	.055	4.	60.	175.	42.0	46.0	48.	51.	1.29	.848	POP	.239-05
N2H4	389	UNLIKE-DOUBLET	.055	.055	4.	60.	175.	37.0	46.0	48.	51.	1.13	1.100	POP	.239-05
N2H4	390	UNLIKE-DOUBLET	.055	.055	4.	60.	175.	35.0	46.0	48.	51.	1.71	.484	POP	.239-05
N2H4	391	UNLIKE-DOUBLET	.055	.055	4.	60.	195.	49.0	60.0	48.	52.	1.17	1.040	PUP	.318-05
N2H4	392	UNLIKE-DOUBLET	.055	.055	4.	60.	195.	49.0	60.0	48.	52.	1.16	1.060	POP	.318-05
N2H4	393	UNLIKE-DOUBLET	.055	.055	4.	60.	415.	37.0	59.0	55.	60.	.88	1.840	SEP	.401-05
N2H4	394	UNLIKE-DOUBLET	.060	.060	4.	60.	235.	61.0	71.0	56.	62.	1.21	.967	MIX	.611-05
N2H4	395	UNLIKE-DOUBLET	.060	.060	4.	60.	225.	51.0	71.0	45.	53.	1.02	1.370	MIX	.440-05
N2H4	396	UNLIKE-DOUBLET	.060	.060	4.	60.	235.	60.0	71.0	38.	45.	1.20	.991	MIX	.334-05
N2H4	397	UNLIKE-DOUBLET	.060	.060	4.	60.	225.	59.0	71.0	63.	62.	1.19	1.520	MIX	.672-05
N2H4	398	UNLIKE-DOUBLET	.060	.060	4.	60.	235.	56.0	71.0	71.	70.	1.35	.931	MIX	.862-05
N2H4	399	UNLIKE-DOUBLET	.060	.060	4.	60.	235.	54.0	71.0	79.	76.	1.09	1.190	MIX	.105-04
N2H4	400	UNLIKE-DOUBLET	.060	.060	4.	60.	235.	53.0	71.0	78.	84.	1.06	1.240	MIX	.122-04
N2H4	401	UNLIKE-DOUBLET	.060	.060	4.	60.	235.	51.0	71.0	83.	87.	1.02	1.360	MIX	.138-04
N2H4	402	UNLIKE-DOUBLET	.060	.060	4.	60.	235.	51.0	69.0	83.	99.	1.60	1.320	MIX	.166-04
N2H4	403	UNLIKE-DOUBLET	.060	.060	4.	60.	255.	50.0	61.0	98.	103.	1.16	1.050	MIX	.190-04
N2H4	404	UNLIKE-DOUBLET	.060	.060	4.	60.	215.	49.0	50.0	97.	108.	1.16	.882	MIX	.168-04
N2H4	405	UNLIKE-DOUBLET	.060	.060	4.	60.	235.	48.0	69.0	99.	48.	.99	1.440	MIX	.766-05
N2H4	406	UNLIKE-DOUBLET	.060	.060	4.	60.	235.	56.0	66.0	63.	66.	1.02	.980	MIX	.678-05
N2H4	407	UNLIKE-DOUBLET	.060	.060	4.	60.	235.	52.0	65.0	63.	66.	1.14	1.090	MIX	.668-05
N2H4	408	UNLIKE-DOUBLET	.060	.060	4.	60.	235.	54.0	65.0	63.	66.	1.11	1.080	MIX	.668-05
N2H4	409	UNLIKE-DOUBLET	.060	.060	4.	60.	235.	50.0	65.0	63.	66.	1.09	1.210	MIX	.668-05
N2H4	410	UNLIKE-DOUBLET	.060	.060	4.	60.	185.	36.0	54.0	76.	85.	.95	1.620	PUP	.925-05

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR ZUNG

FUEL TYPE	TEST NO.	MODE	PC (PSIA)	VAVG	NEF	NEO	REF	REO	DELTI (DEG F)	RELF	RELO	PPF (PSIA)	PPO (PSIA)	MRVP	XF	XO	XP	RESID
N2H4	369	POP	185.	46.	5.8	11.1	.237+05	.694+05	0.	.95+05	.28+06	.2	14.8	178.6	.00	.08	.10-01	.10-03
N2H4	370	PUP	185.	45.	5.5	9.9	.224+05	.644+05	0.	.90+05	.26+06	.2	13.2	189.7	.00	.07	.88-02	.10-03
N2H4	371	POP	135.	43.	5.5	8.0	.222+05	.575+05	0.	.89+05	.23+06	.2	12.6	188.2	.00	.07	.84-02	.10-03
N2H4	372	PUP	185.	42.	5.4	6.5	.210+05	.507+05	0.	.84+05	.20+06	.1	10.1	198.8	.00	.05	.66-02	.10-03
N2H4	373	PUP	95.	56.	3.9	7.4	.251+05	.741+05	0.	.10+06	.30+06	.2	12.6	181.5	.00	.13	.17-01	.76-04
N2H4	374	POP	95.	55.	3.9	7.1	.251+05	.727+05	0.	.10+06	.29+06	.2	12.6	181.5	.00	.13	.17-01	.76-04
N2H4	375	POP	95.	57.	3.9	8.0	.251+05	.769+05	0.	.10+06	.31+06	.2	12.6	181.5	.00	.13	.17-01	.76-04
N2H4	376	POP	165.	57.	6.8	13.9	.251+05	.769+05	0.	.10+06	.31+06	.2	12.6	181.5	.00	.08	.96-02	.76-04
N2H4	377	POP	175.	57.	7.4	14.8	.291+05	.778+05	0.	.12+06	.31+06	.4	13.2	111.2	.00	.08	.12-01	.76-04
N2H4	378	PUP	175.	58.	7.8	16.2	.313+05	.820+05	0.	.13+06	.33+06	.5	14.2	90.3	.00	.08	.15-01	.75-04
N2H4	379	POP	175.	58.	7.7	18.9	.295+05	.100+06	0.	.12+06	.40+06	.4	33.9	265.0	.00	.19	.20-01	.75-04
N2H4	380	POP	175.	57.	8.1	18.6	.355+05	.101+06	0.	.14+06	.41+06	.8	42.5	155.1	.00	.24	.33-01	.75-04
N2H4	381	POP	175.	57.	8.1	19.4	.359+05	.103+06	0.	.14+06	.41+06	.8	42.5	146.2	.00	.24	.34-01	.75-04
N2H4	382	PUP	175.	56.	8.2	17.6	.365+05	.980+05	0.	.15+06	.39+06	.9	39.6	126.2	.01	.23	.34-01	.75-04
N2H4	383	POP	175.	58.	7.2	16.0	.255+05	.806+05	0.	.10+06	.32+06	.2	13.2	177.2	.00	.08	.96-02	.76-04
N2H4	384	PUP	175.	57.	7.4	17.3	.281+05	.907+05	0.	.11+06	.36+06	.3	23.2	214.4	.00	.13	.15-01	.76-04
N2H4	385	POP	175.	56.	7.4	15.1	.281+05	.812+05	0.	.11+06	.32+06	.3	17.3	63.7	.00	.10	.13-01	.76-04
N2H4	388	POP	175.	44.	4.1	8.3	.176+05	.561+05	0.	.70+05	.22+06	.1	8.2	185.8	.00	.05	.58-02	.10-03
N2H4	389	PUP	175.	41.	4.1	6.4	.176+05	.494+05	0.	.70+05	.20+06	.1	8.2	185.8	.00	.05	.58-02	.10-03
N2H4	390	POP	175.	39.	4.1	5.8	.176+05	.468+05	0.	.70+05	.19+06	.1	8.2	185.8	.00	.05	.58-02	.10-03
N2H4	391	POP	195.	54.	7.8	12.6	.231+05	.655+05	0.	.92+05	.26+06	.1	8.2	179.4	.00	.04	.53-02	.76-04
N2H4	392	PUP	195.	54.	7.8	12.6	.231+05	.655+05	0.	.92+05	.26+06	.1	8.2	179.4	.00	.04	.53-02	.76-04
N2H4	393	SEP	415.	49.	16.3	15.8	.240+05	.506+05	0.	.96+05	.20+06	.2	10.1	172.7	.00	.02	.32-02	.78-04
N2H4	394	MIX	235.	66.	14.7	26.6	.320+05	.914+05	0.	.13+06	.37+06	.2	10.4	163.9	.00	.04	.59-02	.70-04
N2H4	395	MIX	225.	61.	13.8	16.9	.300+05	.745+05	0.	.12+06	.30+06	.1	7.6	162.2	.00	.03	[illegible]	.70-04
N2H4	396	MIX	235.	65.	[illegible]	23.8	[illegible]	.882+05	0.	.11+06	.35+06	.1	6.2	184.2	.00	.03	.33-02	.70-04
N2H4	397	MIX	225.	64.	14.1	24.6	.320+05	.917+05	0.	.13+06	.37+06	.2	12.6	195.5	.00	.06	.68-02	.70-04
N2H4	398	MIX	235.	62.	14.9	24.1	.340+05	.909+05	0.	.14+06	.36+06	.2	15.2	178.0	.00	.06	.82-02	.70-04
N2H4	399	MIX	235.	62.	15.1	23.3	.357+05	.918+05	0.	.14+06	.37+06	.3	18.6	183.0	.00	.08	.99-02	.70-04
N2H4	400	MIX	235.	62.	15.3	22.1	.381+05	.896+05	0.	.15+06	.36+06	.4	18.1	136.6	.00	.08	.11-01	.70-04
N2H4	401	MIX	235.	61.	15.4	21.2	.391+05	.889+05	0.	.16+06	.36+06	.4	20.5	136.7	.00	.09	.13-01	.70-04
N2H4	402	MIX	235.	58.	15.9	21.2	.422+05	.889+05	0.	.17+06	.36+06	.6	20.5	96.0	.00	.09	.15-01	.72-04
N2H4	403	MIX	255.	55.	17.8	24.0	.383+05	.961+05	0.	.15+06	.38+06	.7	29.4	117.6	.00	.12	.16-01	.82-04
N2H4	404	MIX	215.	49.	7.3	19.3	.322+05	.936+05	0.	.13+06	.37+06	.9	28.7	99.1	.00	.13	.25-01	.10-03
N2H4	405	MIX	235.	59.	13.5	20.5	.282+05	.929+05	0.	.11+06	.37+06	.1	30.0	694.6	.00	.13	.76-02	.72-04
N2H4	406	MIX	235.	61.	12.4	23.2	.306+05	.870+05	0.	.12+06	.35+06	.2	12.6	169.5	.00	.05	.70-02	.76-04
N2H4	407	MIX	235.	58.	12.4	20.0	.302+05	.808+05	0.	.12+06	.32+06	.2	12.6	169.5	.00	.05	.70-02	.77-04
N2H4	408	MIX	235.	59.	12.4	21.5	.302+05	.839+05	0.	.12+06	.34+06	.2	12.6	169.5	.00	.05	.70-02	.77-04
N2H4	409	MIX	235.	57.	12.4	18.5	.302+05	.777+05	0.	.12+06	.31+06	.2	12.6	169.5	.00	.05	.70-02	.77-04
N2H4	410	POP	185.	45.	7.0	8.0	.292+05	.601+05	0.	.12+06	.24+06	.4	17.3	125.6	.00	.09	.14-01	.93-04

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HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR ZUNG

FUEL TYPE	TEST NO.	INJECTOR TYPE	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	MODE	REACT (SEC)
N2H4	411	UNLIKE-DOUBLET	.060	.060	4.	60.	175.	34.0	55.0	89.	95.	.88	1.850	POP	.134-04
N2H4	412	UNLIKE-DOUBLET	.060	.060	4.	60.	190.	36.0	55.0	87.	97.	.92	1.690	PUP	.135-04
N2H4	413	UNLIKE-DOUBLET	.060	.060	4.	60.	90.	40.0	55.0	83.	89.	1.03	1.340	PUP	.112-04
N2H4	414	UNLIKE-DOUBLET	.060	.060	4.	60.	80.	39.0	54.0	94.	105.	1.01	1.390	POP	.167-04
N2H4	415	UNLIKE-DOUBLET	.060	.060	4.	60.	85.	44.0	54.0	98.	108.	1.14	1.090	POP	.184-04
N2H4	416	UNLIKE-DOUBLET	.060	.060	4.	60.	80.	43.0	54.0	101.	110.	1.13	1.110	PUP	.197-04
N2H4	417	UNLIKE-DOUBLET	.060	.060	4.	60.	80.	41.0	55.0	109.	116.	1.05	1.130	PUP	.240-04
N2H4	418	UNLIKE-DOUBLET	.060	.060	4.	60.	80.	39.0	55.0	102.	116.	.95	1.430	POP	.222-04
N2H4	419	UNLIKE-DOUBLET	.060	.060	4.	60.	80.	37.2	54.3	102.	116.	.98	1.490	POP	.219-04
N2H4	423	UNLIKE-DOUBLET	.060	.060	4.	60.	105.	51.7	54.3	109.	112.	1.35	.780	POP	.224-04
N2H4	424	UNLIKE-DOUBLET	.060	.060	4.	60.	95.	50.3	54.3	103.	114.	1.32	.820	PUP	.216-04
N2H4	425	UNLIKE-DOUBLET	.060	.060	4.	60.	95.	37.2	53.5	75.	89.	.99	1.450	PUP	.985-05
N2H4	426	UNLIKE-DOUBLET	.060	.060	4.	60.	95.	36.2	53.5	64.	81.	.97	1.150	POP	.732-05
N2H4	427	UNLIKE-DOUBLET	.060	.060	4.	60.	95.	34.9	54.7	79.	82.	.91	1.720	PUP	.901-05
N2H4	428	UNLIKE-DOUBLET	.060	.060	4.	60.	95.	39.7	54.7	104.	108.	1.04	1.330	PUP	.200-04
N2H4	429	UNLIKE-DOUBLET	.060	.060	4.	60.	95.	36.3	54.7	106.	114.	.95	1.590	PUP	.225-04
N2H4	430	UNLIKE-DOUBLET	.055	.055	4.	60.	185.	48.7	58.2	68.	75.	1.19	1.000	POP	.622-05
N2H4	431	UNLIKE-DOUBLET	.055	.055	4.	60.	175.	46.7	58.5	81.	93.	1.14	1.100	POP	.105-04
N2H4	432	UNLIKE-DOUBLET	.055	.055	4.	60.	215.	65.4	74.0	92.	101.	1.26	.890	MIX	.174-04
N2H4	433	UNLIKE-DOUBLET	.055	.055	4.	60.	215.	64.4	73.5	97.	106.	1.23	.910	MIX	.202-04
N2H4	434	UNLIKE-DOUBLET	.055	.055	4.	60.	175.	51.0	64.5	101.	114.	1.20	1.060	MIX	.210-04
N2H4	435	UNLIKE-DOUBLET	.055	.055	4.	60.	75.	50.1	60.4	96.	106.	1.18	1.020	PUP	.163-04
N2H4	435	UNLIKE-DOUBLET	.055	.055	4.	60.	95.	45.2	59.8	72.	86.	1.08	1.230	POP	.851-05
N2H4	437	UNLIKE-DOUBLET	.055	.055	4.	60.	95.	45.2	59.8	68.	77.	1.08	1.230	POP	.663-05
N2H4	438	UNLIKE-DOUBLET	.040	.040	4.	60.	45.	54.1	50.8	99.	105.	1.52	.620	MIX	.737-05
N2H4	439	UNLIKE-DOUBLET	.040	.040	4.	60.	45.	49.5	53.4	94.	112.	1.32	.810	MIX	.873-05
N2H4	440	UNLIKE-DOUBLET	.040	.040	4.	60.	45.	57.4	59.7	97.	102.	1.37	.760	MIX	.805-05
N2H4	441	UNLIKE-DOUBLET	.040	.040	4.	60.	45.	48.8	53.4	91.	97.	1.30	.840	MIX	.610-05
N2H4	442	UNLIKE-DOUBLET	.040	.040	4.	60.	45.	56.5	53.4	107.	116.	1.58	.580	MIX	.102-04
N2H4	443	UNLIKE-DOUBLET	.040	.040	4.	60.	45.	54.1	53.4	114.	125.	1.45	.680	SEP	.127-04
N2H4	444	UNLIKE-DOUBLET	.040	.040	4.	60.	45.	60.0	53.4	108.	108.	1.60	.550	MIX	.907-05
N2H4	445	UNLIKE-DOUBLET	.040	.040	4.	60.	45.	50.0	57.4	114.	122.	1.29	.930	SEP	.129-04
N2H4	446	UNLIKE-DOUBLET	.040	.040	4.	60.	45.	49.3	57.4	116.	126.	1.24	.960	SEP	.146-04
N2H4	447	UNLIKE-DOUBLET	.040	.040	4.	60.	45.	50.6	66.6	108.	122.	1.08	1.220	MIX	.140-04
N2H4	448	UNLIKE-DOUBLET	.040	.040	4.	60.	55.	54.1	66.6	104.	114.	1.16	1.060	MIX	.119-04
N2H4	449	UNLIKE-DOUBLET	.040	.040	4.	60.	55.	57.2	66.7	106.	116.	1.16	1.060	MIX	.125-04
N2H4	450	UNLIKE-DOUBLET	.040	.040	4.	60.	55.	54.2	66.6	104.	118.	1.16	1.060	MIX	.126-04
N2H4	451	UNLIKE-DOUBLET	.040	.040	4.	60.	45.	45.7	68.2	101.	106.	1.13	2.570	MIX	.103-04
N2H4	452	UNLIKE-DOUBLET	.040	.040	4.	60.	45.	44.4	65.1	97.	108.	.97	1.510	MIX	.980-05
N2H4	453	UNLIKE-DOUBLET	.040	.040	4.	60.	50.	44.9	65.1	91.	105.	.98	1.470	MIX	.860-05

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HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR ZUNG

FUEL TYPE	TEST NO.	MODE	PC (PSIA)	VAVG	WEF	WEO	REF	REO	DELTI (DEG F)	RELF	RELO	PPF (PSIA)	PPO (PSIA)	MRVP	XF	XO	XP	RESID
N2H4	411	PUP	175.	45.	7.0	7.3	.324+05	.615+05	0.	.13+06	.25+06	.6	23.7	121.3	.00	.14	.21-01	.91-04
N2H4	412	PUP	190.	46.	7.6	8.7	.330+05	.643+05	0.	.13+06	.26+06	.6	22.6	110.4	.00	.12	.19-01	.91-04
N2H4	413	PUP	90.	47.	3.6	5.0	.308+05	.697+05	0.	.12+06	.28+06	.5	20.5	127.5	.01	.23	.34-01	.91-04
N2H4	414	PUP	80.	46.	3.2	4.5	.343+05	.729+05	0.	.14+06	.29+06	.8	26.8	101.4	.01	.34	.57-01	.93-04
N2H4	415	PUP	85.	49.	3.4	6.2	.348+05	.846+05	0.	.14+06	.34+06	.9	29.4	101.2	.01	.35	.59-01	.93-04
N2H4	416	PUP	80.	48.	3.2	5.7	.352+05	.842+05	0.	.14+06	.34+06	.9	31.5	102.2	.01	.39	.67-01	.93-04
N2H4	417	PUP	80.	48.	3.4	5.4	.371+05	.834+05	0.	.15+06	.33+06	1.0	37.8	104.8	.01	.47	.79-01	.91-04
N2H4	418	PUP	80.	47.	3.4	4.7	.371+05	.768+05	0.	.15+06	.31+06	1.0	32.3	90.6	.01	.40	.73-01	.91-04
N2H4	419	PUP	80.	46.	3.3	4.3	.366+05	.732+05	0.	.15+06	.29+06	1.0	32.3	90.6	.01	.40	.73-01	.92-04
N2H4	423	PUP	105.	53.	4.3	11.3	.358+05	.105+06	0.	.14+06	.42+06	1.0	37.8	115.1	.01	.36	.57-01	.92-04
N2H4	424	PUP	95.	52.	3.9	9.3	.362+05	.995+05	0.	.14+06	.40+06	1.0	33.1	96.9	.01	.35	.61-01	.92-04
N2H4	425	PUP	95.	45.	3.6	4.4	.299+05	.618+05	0.	.12+06	.25+06	.5	16.9	106.3	.00	.18	.30-01	.93-04
N2H4	426	PUP	95.	45.	3.5	3.9	.282+05	.567+05	0.	.11+06	.23+06	.3	13.1	112.5	.00	.14	.22-01	.93-04
N2H4	427	PUP	95.	45.	3.7	3.9	.289+05	.594+05	0.	.12+06	.24+06	.4	18.6	152.7	.00	.20	.27-01	.91-04
N2H4	428	PUP	95.	47.	3.9	5.8	.353+05	.789+05	0.	.14+06	.32+06	.9	33.9	115.3	.01	.36	.56-01	.91-04
N2H4	429	PUP	95.	46.	3.9	4.9	.365+05	.728+05	0.	.15+06	.29+06	1.0	35.4	103.4	.01	.37	.63-01	.91-04
N2H4	430	PUP	135.	53.	7.3	13.0	.266+05	.713+05	0.	.11+06	.29+06	.3	14.2	146.0	.00	.08	.11-01	.79-04
N2H4	431	PUP	175.	52.	7.2	12.0	.311+05	.737+05	0.	.12+06	.29+06	.5	19.5	107.2	.00	.11	.18-01	.78-04
N2H4	432	MIX	215.	69.	14.5	30.8	.421+05	.111+06	0.	.17+06	.44+06	.7	25.8	111.7	.00	.12	.19-01	.62-04
N2H4	433	MIX	215.	65.	14.4	30.7	.430+05	.113+06	0.	.17+06	.45+06	.8	29.1	106.1	.00	.14	.22-01	.62-04
N2H4	434	MIX	175.	57.	9.2	16.0	.394+05	.916+05	0.	.16+06	.37+06	1.0	31.5	92.6	.01	.18	.32-01	.71-04
N2H4	435	PUP	75.	55.	3.4	6.4	.353+05	.871+05	0.	.14+06	.35+06	.8	28.1	102.8	.01	.37	.63-01	.76-04
N2H4	436	PUP	95.	52.	4.1	5.9	.300+05	.678+05	0.	.12+06	.27+06	.4	15.8	109.3	.00	.17	.27-01	.77-04
N2H4	437	PUP	95.	52.	4.0	5.7	.279+05	.662+05	0.	.11+06	.26+06	.3	14.2	137.5	.00	.15	.22-01	.77-04
N2H4	438	MIX	45.	53.	1.0	3.3	.215+05	.698+05	0.	.85+05	.28+06	.8	30.0	112.6	.02	.67	.11+00	.66-04
N2H4	439	MIX	45.	51.	1.2	2.7	.235+05	.617+05	0.	.94+05	.25+06	1.0	26.8	83.7	.02	.60	.11+00	.62-04
N2H4	440	MIX	45.	58.	1.4	3.7	.248+05	.733+05	0.	.99+05	.24+06	.7	29.1	120.4	.02	.65	.10+00	.56-04
N2H4	441	MIX	45.	51.	1.1	2.6	.214+05	.596+05	0.	.86+05	.24+06	.6	24.9	120.3	.01	.55	.81-01	.62-04
N2H4	442	MIX	45.	55.	1.2	3.8	.240+05	.759+05	0.	.96+05	.30+06	1.0	36.2	100.8	.02	.81	.14+00	.62-04
N2H4	443	SEP	45.	54.	1.2	3.0	.253+05	.753+05	0.	.10+06	.30+06	1.3	42.5	95.0	.03	.94	.17+00	.62-04
N2H4	444	MIX	45.	57.	1.2	4.3	.236+05	.810+05	0.	.92+05	.32+06	.9	37.0	125.3	.02	.82	.12+00	.62-04
N2H4	445	SEP	45.	53.	1.4	3.1	.267+05	.696+05	0.	.11+06	.28+06	1.2	42.5	101.1	.03	.94	.16+00	.58-04
N2H4	446	SEP	45.	53.	1.4	3.1	.277+05	.693+05	0.	.11+06	.28+06	1.5	44.4	89.9	.03	.99	.18+00	.58-04
N2H4	447	MIX	45.	5[illegible].	1.9	3.1	.310+05	.683+05	0.	.12+06	.27+06	1.2	37.0	89.1	.03	.82	.15+00	.50-04
N2H4	448	MIX	55.	57.	2.2	4.2	.296+05	.717+05	0.	.12+06	.29+06	1.0	33.9	99.1	.02	.62	.11+00	.50-04
N2H4	449	MIX	55.	62.	2.3	4.7	.306+05	.765+05	0.	.12+06	.31+06	1.0	35.4	98.8	.02	.64	.11+00	.50-04
N2H4	450	MIX	55.	[illegible]	2.3	4.2	.313+05	.718+05	0.	.12+06	.29+06	1.1	33.9	90.7	.02	.62	.11+00	.50-04
N2H4	451	MIX	45.	56.	1.9	2.4	.290+05	.547+05	0.	.12+06	.24+06	.8	31.5	114.2	.02	.70	.11+00	.49-04
N2H4	452	MIX	45.	55.	1.7	2.2	.280+05	.567+05	0.	.11+06	.23+06	.9	29.1	100.2	.02	.65	.11+00	.51-04
N2H4	453	MIX	[illegible]	55.	1.9	2.4	.275+05	.544+05	0.	.11+06	.22+06	.8	24.9	94.6	.02	.50	.88-01	.51-04

ORIGINAL PAGE IS OF POOR QUALITY

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR ZUNG

FUEL TYPE	TEST NO.	INJECTOR TYPE	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	MODE	REACT (SEC)
N2H4	454	UNLIKE-DOUBLET	.040	.040	4.	60.	65.	49.8	40.9	114.	132.	1.00	1.430	MIX	.108-04
N2H4	455	UNLIKE-DOUBLET	.040	.040	4.	60.	50.	67.7	68.2	122.	134.	1.41	.712	SEP	.201-04
N2H4	456	UNLIKE-DOUBLET	.040	.040	4.	60.	55.	58.5	66.6	129.	137.	1.25	.913	SEP	.221-04
N2H4	457	UNLIKE-DOUBLET	.040	.040	4.	60.	55.	60.5	66.3	135.	144.	1.29	.852	SEP	.262-04
N2H4	458	UNLIKE-DOUBLET	.040	.040	4.	60.	55.	60.0	64.1	131.	144.	1.33	.801	SEP	.242-04
N2H4	459	UNLIKE-DOUBLET	.040	.040	4.	60.	55.	58.5	62.3	137.	147.	1.34	.797	SEP	.264-04
N2H4	460	UNLIKE-DOUBLET	.060	.060	4.	60.	470.	37.9	66.3	61.	64.	.81	2.150	SEP	.642-05
N2H4	461	UNLIKE-DOUBLET	.060	.060	4.	60.	535.	65.1	66.9	63.	66.	1.34	.789	SEP	.683-05
N2H4	462	UNLIKE-DOUBLET	.060	.060	4.	60.	535.	48.4	68.6	63.	66.	1.00	1.420	SEP	.703-05
N2H4	463	UNLIKE-DOUBLET	.060	.060	4.	60.	535.	46.6	68.8	67.	64.	.96	1.540	SEP	.712-05
N2H4	464	UNLIKE-DOUBLET	.060	.060	4.	60.	585.	56.5	68.8	66.	69.	1.17	1.040	SEP	.782-05
N2H4	465	UNLIKE-DOUBLET	.060	.060	4.	0.	475.	61.3	68.8	67.	64.	1.26	.890	SEP	.712-05
N2H4	466	UNLIKE-DOUBLET	.060	.060	4.	60.	435.	54.9	65.7	46.	52.	1.19	1.000	SEP	.411-05
N2H4	467	UNLIKE-DOUBLET	.060	.060	4.	60.	455.	55.9	65.7	48.	52.	1.21	.970	SEP	.419-05
N2H4	468	UNLIKE-DOUBLET	.060	.060	4.	60.	455.	61.9	65.7	108.	110.	1.35	.790	SEP	.260-04
N2H4	469	UNLIKE-DOUBLET	.060	.060	4.	60.	455.	60.4	68.8	114.	116.	1.25	.910	SEP	.319-04
N2H4	470	UNLIKE-DOUBLET	.060	.060	4.	60.	445.	58.2	68.8	111.	119.	1.21	.980	SEP	.320-04
N2H4	471	UNLIKE-DOUBLET	.060	.060	4.	60.	100.	46.6	52.8	96.	92.	1.26	.900	PUP	.133-04
N2H4	472	UNLIKE-DOUBLET	.060	.060	4.	60.	100.	42.6	52.6	64.	72.	1.15	1.070	PUP	.613-05
N2H4	473	UNLIKE-DOUBLET	.060	.060	4.	60.	100.	46.6	52.6	63.	70.	1.26	.900	PUP	.582-05
N2H4	474	UNLIKE-DOUBLET	.060	.060	4.	60.	100.	42.8	52.6	59.	62.	1.16	1.060	POP	.476-05
N2H4	475	UNLIKE-DOUBLET	.040	.040	4.	60.	630.	59.5	77.9	68.	64.	1.09	1.200	SEP	.362-05
N2H4	476	UNLIKE-DOUBLET	.040	.040	4.	60.	80.	73.5	81.7	68.	64.	1.28	.870	MIX	.380-05
N2H4	477	UNLIKE-DOUBLET	.040	.040	4.	60.	85.	61.3	83.2	61.	66.	1.05	1.290	MIX	.371-05
N2H4	478	UNLIKE-DOUBLET	.040	.040	4.	60.	640.	65.4	70.0	59.	66.	1.33	.807	MIX	.306-05
N2H4	479	UNLIKE-DOUBLET	.060	.060	4.	60.	100.	46.5	52.8	68.	71.	1.25	.905	PUP	.635-05
N2H4	480	UNLIKE-DOUBLET	.060	.060	4.	60.	100.	48.4	53.7	88.	64.	1.2[illegible]	.860	POP	.719-05
N2H4	481	UNLIKE-DOUBLET	.060	.060	4.	60.	25.	26.5	35.1	128.	132.	1.06	1.240	POP	.242-04
N2H4	482	UNLIKE-DOUBLET	.060	.060	4.	60.	147.	25.4	34.9	135.	141.	1.03	1.330	POP	.294-04
N2H4	483	UNLIKE-DOUBLET	.060	.060	4.	60.	175.	43.1	65.1	51.	60.	.95	1.600	POP	.504-05
N2H4	484	UNLIKE-DOUBLET	.060	.060	4.	60.	185.	54.1	64.1	51.	60.	1.20	.986	POP	.396-05
N2H4	485	UNLIKE-DOUBLET	.040	.040	4.	60.	220.	54.1	62.6	57.	60.	1.23	.938	UNDEF	.236-05
N2H4	486	UNLIKE-DOUBLET	.040	.040	4.	60.	90.	54.1	64.1	54.	58.	2.51	.471	MIX	.223-05
N2H4	487	UNLIKE-DOUBLET	.040	.040	4.	60.	100.	54.1	63.1	56.	58.	1.22	.952	MIX	.225-05
N2H4	488	UNLIKE-DOUBLET	.040	.040	4.	60.	100.	54.1	63.8	56.	58.	1.21	.970	MIX	.227-05
N2H4	489	UNLIKE-DOUBLET	.040	.040	4.	60.	100.	54.1	63.8	56.	58.	1.21	.970	MIX	.227-05
N2H4	490	UNLIKE-DOUBLET	.040	.040	4.	60.	150.	39.8	43.4	63.	63.	1.31	.830	MIX	.183-05
N2H4	491	UNLIKE-DOUBLET	.040	.040	4.	60.	30.	38.0	43.4	51.	56.	1.25	.910	MIX	.139-05
N2H4	492	UNLIKE-DOUBLET	.040	.040	4.	60.	30.	38.6	41.4	64.	60.	1.37	.750	MIX	.169-05
N2H4	493	UNLIKE-DOUBLET	.040	.040	4.	60.	30.	33.2	40.8	56.	60.	1.16	1.060	MIX	.149-05

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR ZUNG

FUEL TYPE	TEST NO.	MODE	PC (PSIA)	VAVG	WEF	WED	REF	RED	DELTI (DEG F)	RELF	RELD	PPF (PSIA)	PPD (PSIA)	MRVP	XF	XD	XP	RESID
N2H4	454	MIX	65.	45.	1.0	4.4	.203+05	.693+05	0.	.81+05	.28+06	1.6	42.5	78.7	.02	.65	.13+00	.81-04
N2H4	455	SEP	50.	68.	2.2	6.6	.343+05	.982+05	0.	.14+06	.39+06	1.7	50.6	88.6	.03	1.01	.16+00	.49-04
N2H4	456	SEP	55.	62.	2.4	5.7	.341+05	.882+05	0.	.14+06	.35+06	1.8	58.8	95.9	.03	1.07	.19+00	.50-04
N2H4	457	SEP	55.	63.	2.4	6.4	.353+05	.944+05	0.	.14+06	.38+06	2.2	67.1	90.6	.04	1.22	.22+00	.50-04
N2H4	458	SEP	55.	62.	2.2	6.1	.341+05	.915+05	0.	.14+06	.37+06	2.2	61.4	83.5	.04	1.12	.21+00	.52-04
N2H4	459	SEP	55.	60.	2.1	6.0	.337+05	.924+05	0.	.13+06	.37+06	2.4	69.9	86.7	.04	1.27	.23+00	.54-04
N2H4	460	SEP	470.	54.	25.7	21.1	.303+05	.584+05	0.	.12+06	.23+06	.2	12.1	175.3	.00	.03	.33-02	.75-04
N2H4	461	SEP	535.	66.	29.9	71.1	.310+05	.101+06	.	.12+06	.40+06	.2	12.4	167.6	.00	.02	.31-02	.75-04
N2H4	462	SEP	535.	59.	31.6	39.3	.319+05	.750+05	0.	.13+06	.30+06	.2	12.4	167.6	.00	.02	.31-02	.73-04
N2H4	463	SEP	535.	58.	31.5	37.2	.314+05	.740+05	0.	.13+06	.30+06	.2	13.8	197.9	.00	.03	.31-02	.73-04
N2H4	464	SEP	565.	62.	34.8	59.6	.328+05	.892+05	0.	.13+06	.36+06	.2	13.5	162.4	.00	.02	.31-02	.73-04
N2H4	465	SEP	475.	65.	28.0	57.2	.314+05	.973+05	0.	.13+06	.39+06	.2	13.8	197.9	.00	.03	.35-02	.73-04
N2H4	466	SEP	435.	60.	22.8	38.2	.277+05	.801+05	0.	.11+06	.32+06	.1	7.9	170.7	.00	.02	.24-02	.76-04
N2H4	467	SEP	455.	60.	23.9	41.7	.277+05	.815+05	0.	.11+06	.33+06	.1	8.2	176.4	.00	.02	.23-02	.76-04
N2H4	468	SEP	455.	64.	26.9	69.6	.428+05	.125+06	0.	.17+06	.50+06	.9	37.0	118.7	.00	.08	.13-01	.76-04
N2H4	469	SEP	455.	64.	29.9	68.7	.464+05	.126+06	0.	.19+06	.50+06	1.0	42.5	116.7	.00	.09	.15-01	.73-04
N2H4	470	SEP	445.	63.	29.4	61.2	.472+05	.120+06	0.	.19+06	.48+06	1.1	39.6	102.6	.00	.09	.15-01	.73-04
N2H4	471	POP	100.	49.	3.7	8.1	.303+05	.884+05	0.	.12+06	.35+06	.5	28.1	154.8	.01	.28	.38-01	.95-04
N2H4	472	POP	100.	47.	3.5	5.7	.256+05	.667+05	0.	.10+06	.27+06	.3	13.1	146.6	.00	.13	.18-01	.95-04
N2H4	473	POP	100.	49.	3.5	6.8	.252+05	.724+05	0.	.10+06	.29+06	.2	12.6	149.9	.00	.13	.18-01	.95-04
N2H4	474	POP	100.	47.	3.4	5.7	.237+05	.653+05	0.	.95+05	.26+06	.2	11.5	179.8	.00	.12	.15-01	.95-04
N2H4	475	SEP	630.	64.	31.7	47.9	.237+05	.633+05	0.	.95+05	.25+06	.2	14.2	202.0	.00	.02	.27-02	.43-04
N2H4	476	POP	80.	77.	4.4	9.3	.249+05	.782+05	0.	.10+06	.31+06	.2	14.2	202.0	.00	.18	.21-01	.41-04
N2H4	477	POP	35.	72.	4.9	6.6	.257+05	.628+05	0.	.10+06	.25+06	.2	12.0	161.7	.00	.14	.19-01	.40-04
N2H4	478	POP	640.	67.	26.1	56.4	.217+05	.665+05	0.	.87+05	.27+06	.2	11.5	155.9	.00	.02	.25-02	.48-04
N2H4	479	POP	100.	49.	3.5	7.0	.256+05	.742+05	0.	.10+06	.30+06	.3	14.2	159.9	.00	.14	.19-01	.95-04
N2H4	480	POP	100.	51.	3.6	8.4	.245+05	.870+05	0.	.98+05	.35+06	.2	23.2	318.4	.00	.23	.22-01	.93-04
N2H4	481	POP	23.	31.	.4	.7	.261+05	.596+05	0.	.10+06	.24+06	1.6	57.6	104.3	.07	2.51	.42+00	.14-03
N2H4	482	POP	147.	30.	2.6	4.5	.274+05	.595+05	0.	.11+06	.24+06	2.0	67.1	99.1	.01	.46	.78-01	.14-03
N2H4	483	POP	175.	54.	9.2	9.7	.290+05	.632+05	0.	.12+06	.25+06	.2	9.0	152.0	.00	.05	.72-02	.77-04
N2H4	484	POP	165.	59.	9.4	16.1	.286+05	.793+05	0.	.11+06	.32+06	.2	9.0	152.0	.00	.05	.68-02	.78-04
N2H4	485	[illegible]	220.	58.	7.1	13.1	.186+05	.545+05	0.	.74+05	.22+06	.2	10.9	181.3	.00	.05	.63-02	.53-04
N2H4	486	MIX	90.	57.	3.0	5.3	.188+05	.536+05	0.	.75+05	.21+06	.2	10.0	177.2	.00	.11	.14-01	.52-04
N2H4	487	MIX	100.	58.	3.3	5.9	.185+05	.541+05	0.	.74+05	.22+06	.2	10.4	184.9	.00	.10	.13-01	.53-04
N2H4	488	MIX	100.	58.	3.3	5.9	.187+05	.541+05	0.	.75+05	.22+06	.2	10.4	184.9	.00	.10	.13-01	.52-04
N2H4	489	MIX	100.	58.	3.3	5.9	.187+05	.541+05	0.	.75+05	.22+06	.2	10.4	184.9	.00	.10	.13-01	.52-04
N2H4	490	MIX	150.	41.	2.5	5.0	.131+05	.411+05	0.	.52+05	16+06	.2	12.4	189.6	.00	.08	.10-01	.77-04
N2H4	491	MIX	30.	40.	.5	.9	.125+05	.371+05	0.	.50+05	.15+06	.2	9.0	170.9	.01	.30	.39-01	.77-04
N2H4	492	MIX	30.	40.	.4	.9	.122+05	.403+05	0.	.49+05	.16+06	.2	13.1	219.1	.01	.44	.50-01	.81-04
N2H4	493	MIX	50.	37.	.4	.7	.121+05	.332+05	0.	.48+05	.13+06	.2	10.4	177.7	.01	.35	.44-01	.82-04

ORIGINAL PAGE IS OF POOR QUALITY

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR ZUNG

FUEL TYPE	TEST NO.	INJECTOR TYPE	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	MODE	REACT (SEC)
N2H4	494	UNLIKE-DOUBLET	.040	.040	4.	60.	30.	33.9	40.3	56.	62.	1.16	1.040	MIX	.156-05
N2H4	495	UNLIKE-DOUBLET	.040	.040	4.	60.	35.	38.3	43.4	56.	64.	1.26	.900	MIX	.175-05
N2H4	496	UNLIKE-DOUBLET	.040	.040	4.	60.	35.	36.6	43.4	56.	66.	1.21	.980	MIX	.180-05
N2H4	497	UNLIKE-DOUBLET	.040	.040	4.	60.	30.	39.8	44.8	56.	66.	1.27	.890	MIX	.186-05
N2H4	498	UNLIKE-DOUBLET	.040	.040	4.	60.	30.	39.8	44.8	58.	66.	1.27	.890	MIX	.192-05
N2H4	499	UNLIKE-DOUBLET	.040	.040	4.	60.	30.	39.6	43.4	56.	64.	1.31	.830	MIX	.175-05
N2H4	500	UNLIKE-DOUBLET	.040	.040	4.	60.	30.	39.6	43.4	56.	66.	1.31	.830	MIX	.180-05
N2H4	501	UNLIKE-DOUBLET	.040	.040	4.	60.	30.	30.6	38.3	63.	74.	1.14	1.090	MIX	.200-05
N2H4	502	UNLIKE-DOUBLET	.040	.040	4.	60.	30.	33.2	37.3	64.	69.	1.27	.880	MIX	.183-05
N2H4	503	UNLIKE-DOUBLET	.040	.040	4.	60.	30.	33.2	38.3	66.	74.	1.23	.930	MIX	.208-05
N2H4	504	UNLIKE-DOUBLET	.040	.040	4.	60.	30.	33.7	31.[illegible]	64.	74.	1.54	.598	MI	.167-05
N2H4	505	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	20.7	17.2	72.	92.	1.71	.488	SEP	.143-05
N2H4	506	UNLIKE-DOUBLET	.040	.040	4.	60.	15.	21.4	21.7	72.	72.	1.40	.721	SEP	.123-05
N2H4	507	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	41.4	27.4	71.	71.	2.20	.296	SEP	.686-06
N2H4	508	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	40.3	39.2	68.	70.	1.48	.650	MIX	.931-06
N2H4	509	UNLIKE-DOUBLET	.027	.027	4.	60.	15.	47.1	53.2	68.	68.	1.27	.890	MIX	.122-05

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR ZUNG

FUEL TYPE	TEST NO.	MODE	PC (PSIA)	VAVG	WEF	WEU	REF	REO	DFLTI (DEG F)	RELF	RELO	PPF (PSIA)	PPU (PSIA)	MRVP	XF	XU	XP	FESID
N2H4	494	MIX	30.	37.	.4	.7	.123+05	.339+05	0.	.49+05	.14+06	.2	10.4	163.9	.01	.35	.46-01	.82-04
N2H4	495	MIX	35.	41.	.5	1.0	.133+05	.383+05	0.	.53+05	.15+06	.2	10.4	149.5	.01	.30	.42-01	.77-04
N2H4	496	MIX	35.	40.	.5	1.0	.134+05	.366+05	0.	.54+05	.15+06	.2	10.4	142.1	.01	.30	.43-01	.77-04
N2H4	497	MIX	30.	2.	.5	1.0	.139+05	.398+05	0.	.55+05	.16+06	.2	10.4	142.1	.01	.35	.50-01	.74-04
N2H4	498	MIX	30.	42.	.5	1.0	.139+05	.402+05	0.	.55+05	.16+06	.2	11.0	150.0	.01	.37	.5[illegible]-01	.74-04
N2H4	499	MIX	30.	41.	.5	1.0	.133+05	.396+05	0.	.53+05	.16+06	.2	10.[illegible]	149.5	.01	.35	.49-01	.77-04
N2H4	500	MIX	30.	41.	.5	1.0	.134+05	.396+05	0.	.54+05	.16+06	.2	10[illegible]	[illegible].1	.01	.35	.50-01	.77-04
N2H4	501	MIX	30.	34.	.4	.6	.126+05	.316+05	0.	.50+05	.13+06	.3	12.[illegible]	[illegible].0	.01	.41	.62-01	.87-04
N2H4	502	MIX	30.	35.	.3	.7	.118+05	.347+05	0.	.47+05	.14+06	.2	13.1	[illegible].6	.01	.44	.59-01	.89-04
N2H4	503	MIX	30.	35.	.4	.7	.126+05	.350+05	0.	.50+05	.14+06	.3	13.5	143.7	.01	.45	.64-01	.87-04
N2H4	504	MIX	30.	33.	.2	.7	.103+05	.352+05	0.	.41+05	.14+06	.3	13.1	159.1	.01	.44	.63-01	.11-03
N2H4	505	SEP	15.	19.	.0	.1	.659+04	.225+05	0.	.26+05	.90+05	.3	15.6	90.0	.04	1.0[illegible]	.19+00	.19-03
N2H4	506	SEP	15.	[illegible]	.1	.1	.704+04	.233+05	0.	.28+05	.93+05	.3	15.6	172.7	.0[illegible]	1.[illegible]6	.14+00	.15-03
N2H4	507	SEP	15.	37.	.1	.4	.595+04	.302+05	0.	.24+05	.12+06	.3	15.2	173.1	.02	1.[illegible]3	.13+00	.82-04
N2H4	508	MIX	15.	40.	.1	.3	.844+04	.290+05	0.	.34+05	.12+06	.2	14.2	166.8	.02	.5[illegible]	.13+00	.57-04
N2H4	509	MIX	15.	50.	.2	.5	.113+05	.338+05	0.	.45+05	.14+06	.2	14.2	177.0	.02	.9	.12+00	.42-04

ZETA PLOT FILE HAS BEEN CREATED... 7290 CHARACTERS

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ORIGINAL PAGE IS OF POOR QUALITY

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR OMS-75

FUEL TYPE	TEST NO.	INJECTOR TYPE	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	MODE	REACT (SEC)
MMH	101	VDT - 360	.027	.025	5.	0.	120.	85.0	96.5	83.	83.	1.69	.783	SEP	.106-04
MMH	102	VDT - 360	.027	.025	5.	0.	105.	66.0	111.1	83.	83.	1.68	1.016	SEP	.122-04
MMH	103	VDT - 360	.027	.025	5.	0.	115.	81.9	94.0	72.	77.	1.69	.794	SEP	.822-05
MMH	104	VDT - 360	.027	.025	5.	0.	116.	81.7	94.5	76.	76.	1.67	.811	SEP	.855-05
MMH	105	VDT - 360	.027	.025	5.	0.	133.	90.0	108.0	78.	76.	1.60	.875	SEP	.100-04
MMH	106	VDT - 360	.027	.025	5.	0.	128.	82.5	98.5	30.	80.	1.61	.865	M/S	.995-05
MMH	107	VDT - 360	.027	.025	5.	0.	127.	84.9	100.7	78.	80.	1.63	.852	M/S	.994-05
MMH	108	VDT - 360	.027	.025	5.	0.	103.	66.5	79.1	81.	82.	1.62	.858	MIX	.834-05
MMH	109	VDT - 360	.027	.025	5.	0.	81.	56.5	64.0	84.	84.	1.69	.779	MIX	.722-05
MMH	110	VDT - 360	.027	.025	5.	0.	158.	98.0	115.3	77.	80.	1.64	.837	SEP	.113-04
MMH	111	VDT - 360	.027	.025	5.	0.	172.	80.6	96.6	81.	160.	1.68	.831	SEP	.309-04
MMH	112	VDT - 360	.027	.025	5.	0.	131.	80.3	101.6	84.	251.	1.70	.868	SEP	.941-04
MMH	113	VDT - 360	.027	.025	5.	0.	132.	81.8	93.7	90.	111.	1.42	.789	SEP	.171-04
MMH	114	VDT - 360	.027	.025	5.	0.	131.	80.8	94.0	76.	77.	1.66	.819	SEP	.865-05
MMH	115	XDT-A	.024	.020	1.	0.	116.	60.6	89.7	80.	84.	1.60	1.329	M/S	.588-05
MMH	116	XDT-A	.024	.020	1.	0.	133.	58.7	84.8	84.	84.	1.63	1.269	MIX	.612-05
MMH	117	XDT-A	.024	.020	1.	0.	103.	46.1	68.7	84.	86.	1.58	1.347	MIX	.509-05
MMH	118	XDT-A	.024	.020	1.	0.	82.	38.7	56.1	86.	89.	1.63	1.276	MIX	.443-05
MMH	119	XDT-A	.024	.020	1.	0.	159.	68.2	98.3	82.	84.	1.65	1.261	SEP	.692-05
MMH	120	XDT-A	.024	.020	1.	0.	131.	58.0	88.0	85.	162.	1.63	1.335	SEP	.194-04
MMH	121	XDT-A	.024	.020	1.	0.	130.	59.0	91.0	90.	224.	1.67	1.328	SEP	.442-04
MMH	122	XDT-A	.024	.020	1.	0.	130.	59.8	91.4	120.	241.	1.67	1.317	SEP	.729-04
MMH	123	XDT-A	.024	.020	1.	0.	157.	72.8	113.3	136.	292.	1.68	1.328	SEP	.179-03
MMH	124	LOL CORE LO DP	.027	.025	5.	1.	127.	70.1	91.5	66.	71.	1.48	1.027	UNDEF	.670-05
MMH	125	LOL CORE LO DP	.027	.025	5.	1.	130.	72.0	83.7	70.	77.	1.67	.815	UNDEF	.712-05
MMH	126	LOL CORE LO DP	.027	.025	5.	1.	101.	56.6	68.6	80.	89.	1.59	.886	UNDEF	.783-05
MMH	127	LOL CORE LO DP	.027	.025	5.	1.	82.	46.2	56.3	81.	80.	1.57	.901	UNDEF	.576-05
MMH	128	LOL CORE LO DP	.027	.025	5.	1.	151.	83.8	99.1	86.	81.	1.62	.853	UNDEF	.110-04
MMH	129	LOL CORE LO DP	.027	.025	5.	1.	152.	86.1	98.7	86.	84.	1.67	.801	UNDEF	.114-04
MMH	130	LOL CORE LO DP	.027	.025	5.	1.	130.	73.7	88.0	83.	179.	1.70	.816	UNDEF	.369-04
MMH	131	LOL CORE LO DP	.027	.025	5.	1.	129.	76.2	92.3	87.	234.	1.75	.809	UNDEF	.740-04
MMH	132	LOL CORE LO DP	.027	.025	5.	1.	130.	79.6	91.2	127.	227.	1.78	.755	UNDEF	.109-03
MMH	133	LOL CORE LO DP	.027	.025	5.	1.	150.	93.0	117.2	136.	291.	1.69	.871	UNDEF	.281-03
MMH	134	L-O-L BARRIER	.025	.025	5.	1.	129.	127.0	146.3	70.	76.	1.44	.800	UNDEF	.127-04
MMH	135	L-O-L BARRIER	.025	.025	5.	1.	103.	100.6	115.6	74.	77.	1.44	.798	UNDEF	.104-04
MMH	136	L-O-L BARRIER	.025	.025	5.	1.	82.	81.6	92.4	77.	78.	1.46	.778	UNDEF	.875-05
MMH	137	L-O-L BARRIER	.025	.025	5.	1.	151.	154.5	172.2	76.	76.	1.48	.753	UNDFF	.156-04
MMH	138	L-O-L BARRIER	.025	.025	5.	1.	124.	130.9	156.5	51.	207.	1.49	.802	UNDEF	.895-04
MMH	139	L-O-L BARRIER	.025	.025	5.	1.	124.	131.3	167.5	82.	240.	1.43	.889	UNDEF	[illegible]
MMH	140	L-O-L BARRIER	.025	.025	5.	1.	125.	139.9	165.6	120.	248.	1.50	.786	UNDEF	[illegible]

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR UMS-75

FUEL TYPE	TEST NO.	MODE	PC (PSIA)	VAVG	WEF	WEO	REF	REU	DELTI (DEG F)	RELF	RELU	PPF (PSIA)	PPU (PSIA)	MRVP	XF	XO	XP	RESID
MMH	101	SEP	120.	89.	11.8	13.6	.222+05	.666+05	0.	.11+06	.33+06	1.2	20.5	34.0	.01	.17	.42-01	.22-04
MMH	102	SEP	105.	95.	13.7	12.1	.255+05	.674+05	0.	.13+06	.34+06	1.2	20.5	34.0	.01	.20	.47-01	.19-04
MMH	103	SEP	115.	86.	10.6	11.4	.205+05	.602+05	0.	.10+06	.30+06	1.0	15.6	33.6	.01	.14	.35-01	.22-04
MMH	104	SEP	116.	86.	10.8	11.7	.204+05	.614+05	0.	.10+06	.31+06	1.0	17.3	34.6	.01	.15	.36-01	.22-04
MMH	105	SEP	133.	97.	16.2	16.4	.233+05	.684+05	0.	.12+06	.34+06	1.0	18.1	36.1	.01	.14	.32-01	.19-04
MMH	106	M/S	128.	89.	15.1	13.4	.220+05	.635+05	0.	.11+06	.32+06	1.1	19.0	33.9	.01	.15	.36-01	.21-04
MMH	107	M/S	127.	91.	13.5	13.9	.225+05	.646+05	0.	.11+06	.32+06	1.1	18.1	32.5	.01	.14	.35-01	.21-04
MMH	108	MIX	103.	71.	6.8	7.1	.180+05	.515+05	0.	.90+05	.26+06	1.2	19.5	33.1	.01	.19	.47-01	.26-04
MMH	109	MIX	81.	59.	3.5	4.1	.148+05	.446+05	0.	.74+05	.22+06	1.2	21.1	34.0	.02	.26	.63-01	.33-04
MMH	110	SEP	158.	105.	22.1	23.0	.258+05	.741+05	0.	.13+06	.37+06	1.1	17.7	31.8	.01	.11	.28-01	.18-04
MMH	111	SEP	132.	87.	14.9	13.3	.389+05	.624+05	0.	.19+06	.31+06	8.2	19.5	5.4	.06	.15	.96-01	.22-04
MMH	112	SEP	131.	88.	19.8	13.3	.722+05	.633+05	0.	.36+06	.32+06	43.9	21.1	1.3	.33	.16	.23+00	.21-04
MMH	113	SEP	132.	87.	12.9	14.3	.269+05	.671+05	0.	.13+06	.34+06	2.6	24.2	19.5	.02	.18	.60-01	.22-04
MMH	114	SEP	131.	86.	12.1	12.9	.205+05	.608+05	0.	.10+06	.30+06	1.0	17.3	33.7	.01	.13	.32-01	.22-04
MMH	115	M/S	116.	72.	7.9	5.8	.162+05	.415+05	0.	.16+05	.41+05	1.1	19.0	33.1	.01	.16	.40-01	.19-04
MMH	116	MIX	133.	69.	8.1	6.4	.157+05	.411+05	0.	.16+05	.41+05	1.2	21.1	34.0	.01	.16	.38-01	.20-04
MMH	117	MIX	103.	55.	4.1	3.1	.130+05	.324+05	0.	.13+05	.32+05	1.3	21.1	32.5	.01	.20	.51-01	.24-04
MMH	118	MIX	82.	45.	2.2	1.7	.108+05	.275+05	0.	.11+05	.27+05	1.4	22.1	32.0	.02	.27	.68-01	.30-04
MMH	119	SEP	159.	80.	13.0	10.2	.182+05	.472+05	0.	.18+05	.47+05	1.2	20.0	32.4	.01	.13	.31-01	.17-04
MMH	120	SEP	131.	69.	9.9	6.2	.288+05	.409+05	0.	.29+05	.41+05	8.5	21.6	5.8	.07	.16	.10+00	.19-04
MMH	121	SEP	130.	71.	11.9	6.5	.439+05	.430+05	0.	.44+05	.43+05	28.8	24.2	2.1	.22	.19	.20+00	.18-04
MMH	122	SEP	130.	72.	12.4	8.0	.489+05	.515+05	0.	.49+05	.52+05	36.3	48.2	3.2	.28	.37	.32+00	.18-04
MMH	123	SEP	157.	88.	26.0	16.2	.826-05	.694+05	0.	.83+05	.69+05	76.0	71.3	2.4	.48	.45	.47+00	.15-04
MMH	124	UNDEF	127.	79.	11.0	9.0	.169+05	.498+05	0.	.94+05	.25+06	.8	13.5	32.2	.01	.11	.27-01	.23-04
MMH	125	UNDEF	130.	76.	9.5	9.9	.183+05	.523+05	0.	.91+05	.26+06	1.0	14.8	29.1	.01	.11	.30-01	.25-04
MMH	126	UNDEF	101.	61.	5.1	5.0	.166+05	.436+05	0.	.83+05	.22+06	1.4	19.0	27.8	.01	.19	.51-01	.30-04
MMH	127	UNDEF	82.	50.	2.7	2.7	.126+05	.358+05	0.	.63+05	.18+06	1.1	19.5	34.8	.01	.24	.57-01	.37-04
MMH	128	UNDEF	151.	90.	15.6	16.8	.224+05	.669+05	0.	.11+06	.33+06	1.1	22.1	38.1	.01	.15	.33-01	.21-04
MMH	129	UNDEF	152.	91.	15.7	17.9	.229+05	.688+05	0.	.11+06	.34+06	1.2	22.1	35.5	.01	.15	.34-01	.21-04
MMH	130	UNDEF	130.	79.	12.6	11.0	.401+05	.578+05	0.	.20+06	.29+06	12.5	20.5	3.9	.10	.16	.12+00	.24-04
MMH	131	UNDEF	129.	82.	15.5	12.0	.592+05	.613+05	0.	.30+06	.31+06	33.0	22.6	1.7	.26	.18	.21+00	.23-04
MMH	132	UNDEF	130.	84.	15.0	16.7	.560+05	.801+05	0.	.28+06	.40+06	30.0	56.5	4.4	.23	.43	.32+00	.23-04
MMH	133	UNDEF	150.	102.	33.2	27.9	.106+06	.985+05	0.	.53+06	.49+06	74.7	68.5	2.3	.50	.46	.48+00	.18-04
MMH	134	UNDEF	129.	135.	25.8	[illegible]	.316+05	.854+05	0.	.16+06	.43+06	1.0	14.8	29.9	.01	.11	.30-01	.14-04
MMH	135	UNDEF	135.	167.	14.4	[illegible]	.252+05	.693+05	0.	.13+06	.35+06	1.0	16.5	32.1	.01	.16	.40-01	.18-04
MMH	136	UNDEF	82.	[illegible]	7.3	7.7	.203+05	.571+05	0.	.10+06	.29+06	1.1	17.7	33.5	.01	.22	.53-01	.23-04
MMH	137	UNDEF	151.	162.	46.8	50.3	.372+05	.108+06	0.	.19+06	.54+06	1.0	17.3	34.6	.01	.11	.28-01	.12-04
MMH	138	UNDEF	124.	141.	40.4	30.4	.851+05	.938+05	0.	.43+06	.47+06	21.9	19.5	2.2	.18	.16	.17+00	.13-04
MMH	139	UNDEF	124.	146.	44.7	30.8	.111+06	.947+05	0.	.56+06	.47+06	35.5	20.0	1.5	.29	.16	.22+00	.12-04
MMH	140	UNDEF	125.	150.	[illegible]	43.8	.116+06	.125+06	0.	.58+06	.63+06	41.6	48.2	2.8	.33	.39	.36+00	.13-04

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HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR OMS-75

FUEL TYPE	TEST NO.	INJECTOR TYPE	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	MODE	REACT (SEC)
MMH	141	L-O-L BARRIER	.025	.025	5.	1.	122.	140.7	188.3	126.	312.	1.40	.955	UNDEF	.498-03
MMH	142	L-O-L CORE	.027	.025	5.	1.	126.	124.7	145.6	74.	80.	1.66	.823	SEP	.137-04
MMH	143	L-O-L CORE	.027	.025	5.	1.	101.	100.2	118.0	76.	81.	1.63	.839	M/S	.116-04
MMH	144	L-O-L CORE	.027	.025	5.	1.	81.	83.6	95.9	80.	82.	1.68	.797	SEP	.998-05
MMH	145	L-O-L CORE	.027	.025	5.	1.	153.	153.8	170.8	80.	78.	1.73	.750	SEP	.167-04
MMH	146	L-O-L CORE	.027	.025	5.	1.	124.	127.5	155.3	72.	191.	1.70	.835	SEP	.650-04
MMH	147	L-O-L CORE	.027	.025	5.	1.	123.	130.0	164.4	74.	252.	1.72	.858	SEP	.136-03
MMH	148	L-O-L CORE	.027	.025	5.	1.	123.	136.9	165.9	123.	263.	1.73	.815	SEP	.272-03
MMH	149	L-O-L CORE	.027	.025	5.	1.	147.	164.9	210.0	128.	311.	1.72	.866	SEP	.561-03
MMH	150	VDT-A CORE	.047	.042	9.	0.	114.	42.8	54.9	85.	95.	1.62	.994	SEP	.211-04
MMH	151	VDT-A CORE	.047	.042	9.	0.	95.	48.5	66.2	85.	170.	1.59	1.075	SEP	.715-04
MMH	152	LAM L-O-L CORE	.027	.025	5.	1.	127.	125.6	149.5	80.	82.	1.61	.859	SEP	.156-04
MMH	153	LAM L-O-L CORE	.027	.025	5.	1.	100.	99.9	122.0	82.	84.	1.57	.906	SEP	.134-04
MMH	154	LAM L-O-L CORE	.027	.025	5.	1.	80.	83.0	97.2	83.	86.	1.64	.832	M/S	.111-04
MMH	155	LAM L-O-L CORE	.027	.025	5.	1.	152.	154.0	168.3	82.	85.	1.76	.723	SEP	.187-04
MMH	156	LAM L-O-L CORE	.027	.025	5.	1.	100.	103.3	118.5	82.	87.	1.68	.797	SEP	.136-04
MMH	157	LAM L-O-L CORE	.027	.025	5.	1.	127.	128.0	142.0	81.	83.	1.73	.747	SEP	.152-04
MMH	158	LAM L-O-L CORE	.027	.025	5.	1.	126.	126.9	153.9	74.	189.	1.71	.831	SEP	.645-04
MMH	160	LAM L-O-L CORE	.027	.025	5.	1.	126.	127.7	160.6	76.	225.	1.68	.871	SEP	.104-03
MMH	161	LAM L-O-L CORE	.027	.025	5.	1.	125.	134.4	159.1	126.	240.	1.73	.796	SEP	.210-03
MMH	162	LAM L-O-L CORE	.027	.025	5.	1.	148.	160.9	199.9	129.	296.	1.73	.837	SEP	.469-03
MMH	163	LAM L-O-L CORE	.027	.025	5.	1.	125.	126.3	140.3	76.	94.	1.75	.740	SEP	.168-04
MMH	164	LAM L-O-L CORE	.027	.025	5.	1.	125.	124.7	141.2	77.	92.	1.71	.770	SEP	.164-04
MMH	165	LAM L-O-L CORE	.027	.025	5.	1.	125.	125.1	140.9	78.	89.	1.72	.765	SEP	.157-04
MMH	166	LAM L-O-L CORE	.027	.025	5.	1.	81.	86.6	92.1	82.	91.	1.82	.683	M/S	.112-04
MMH	167	LAM L-O-L CORE	.027	.025	5.	1.	79.	84.4	92.0	83.	89.	1.76	.718	M/S	.109-04
MMH	168	XDT-A	.024	.021	1.	0.	127.	56.5	82.5	83.	88.	1.48	1.292	UNDEF	.683-05
MMH	169	XDT-A	.024	.021	1.	0.	127.	54.7	73.3	83.	89.	1.61	1.087	UNDEF	.614-05
MMH	170	XDT-A	.024	.021	1.	0.	127.	54.7	73.3	83.	89.	1.61	1.087	M/S	.614-05
MMH	171	XDT-A	.024	.021	1.	0.	126.	54.7	71.9	84.	94.	1.64	1.044	UNDEF	.669-05
MMH	172	XDT-A	.024	.021	1.	0.	126.	55.1	72.8	85.	96.	1.64	1.053	UNDEF	.711-05
MMH	173	XDT-A	.024	.021	1.	0.	126.	55.5	72.8	85.	97.	1.64	1.040	M/S	.723-05
MMH	174	XDT-A	.024	.021	1.	0.	125.	55.6	73.7	85.	99.	1.65	1.050	M/S	.757-05
MMH	222	VDT-A CORE	.047	.042	9.	0.	124.	42.4	52.2	76.	75.	1.68	.918	SEP	.131-04
MMH	223	VDT-A CORE	.047	.042	9.	0.	101.	35.5	42.7	77.	76.	1.72	.876	SEP	.110-04
MMH	224	VDT-A CORE	.047	.042	9.	0.	81.	29.1	34.8	78.	77.	1.73	.868	M/S	.926-05
MMH	225	VDT-A CORE	.047	.042	9.	0.	149.	52.4	63.0	78.	77.	1.72	.876	SEP	.167-04
MMH	226	VDT-A CORE	.047	.042	9.	0.	124.	43.8	56.2	83.	169.	1.72	.936	SEP	.742-04
MMH	227	VDT-A CORE	.047	.042	9.	0.	123.	43.7	58.7	80.	232.	1.70	.992	SEP	.120-03
MMH	228	VDT-A CORE	.047	.042	9.	0.	124.	45.6	58.6	125.	242.	1.72	.937	SEP	.221-03

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR OMS-75

FUEL TYPE	TEST NO.	MODE	PC (PSIA)	VAVG	WEF	WEO	REF	REO	DELTI (DEG F)	RELF	RELO	PPF (PSIA)	PPO (PSIA)	MRVP	XF	XO	XP	PESIO
MMH	141	UNDEF	122.	161.	73.6	44.9	.193+06	.130+06	0.	.97+06	.65+06	100.6	[illegible]	1.4	.82	.45	.61+00	.11-04
MMH	142	SEP	126.	133.	28.1	29.2	.326+05	.926+05	0.	.16+06	.46+06	1.1	10.5	29.7	.01	.13	.34-01	.14-04
MMH	143	M/S	101.	107.	14.8	15.3	.267+05	.753+05	0.	.13+06	.38+06	1.1	17.3	30.4	.01	.17	.44-01	.18-04
MMH	144	SEP	81.	86.	7.9	8.7	.218+05	.644+05	0.	.11+06	.32+06	1.2	19.0	32.3	.01	.23	.58-01	.22-04
MMH	145	SEP	153.	160.	46.8	55.7	.376+05	.118+06	0.	.19+06	.59+06	1.1	19.0	35.7	.01	.12	.29-01	.12-04
MMH	146	SEP	124.	138.	38.5	29.8	.765+05	.937+05	0.	.38+06	.47+06	15.6	15.6	2.5	.13	.13	.15+00	.13-04
MMH	147	SEP	123.	143.	48.7	31.0	.118+06	.966+05	0.	.59+06	.48+06	44.6	16.5	1.0	.36	.13	.22+00	.13-04
MMH	148	SEP	123.	148.	51.0	45.5	.127+06	.135+06	0.	.63+06	.67+06	53.0	51.3	2.4	.43	.42	.43+00	.13-04
MMH	149	SEP	147.	181.	109.9	81.4	.214+06	.167+06	0.	.11+07	.83+06	99.3	[illegible]	1.5	.66	.39	.51+00	.99-05
MMH	150	SEP	114.	47.	6.2	5.8	.234+05	.592+05	0.	.21+06	.53+06	1.7	21.6	25.9	.01	.19	.53-01	.64-04
MMH	151	SEP	95.	55.	8.6	6.2	.479+05	.671+05	0.	.43+06	.60+06	10.2	21.6	4.9	.11	.23	.16+00	.53-04
MMH	152	SEP	127.	135.	30.0	30.8	.341+05	.967+05	0.	.17+06	.48+06	1.2	19.0	32.3	.01	.15	.37-01	.14-04
MMH	153	SEP	100.	108.	15.8	15.5	.283+05	.778+05	0.	.14+06	.39+06	1.2	20.0	32.4	.01	.20	.50-01	.17-04
MMH	154	M/S	80.	88.	8.0	8.6	.229+05	.651+05	0.	.11+06	.33+06	1.3	20.5	31.8	.02	.26	.65-01	.21-04
MMH	155	SEP	152.	159.	45.6	56.1	.393+05	.120+06	0.	.20+06	.60+06	1.3	20.0	31.7	.01	.13	.33-01	.12-04
MMH	156	SEP	100.	109.	14.9	16.6	.281+05	.805+05	0.	.14+06	.40+06	1.3	20.0	30.4	.01	.20	.52-01	.18-04
MMH	157	SEP	127.	133.	27.1	32.2	.326+05	.991+05	0.	.16+06	.50+06	1.2	19.5	32.4	.01	.15	.38-01	.15-04
MMH	158	SEP	126.	137.	36.3	30.3	.748+05	.943+05	0.	.37+06	.47+06	15.0	16.5	2.7	.12	.13	.12+00	.14-04
MMH	160	SEP	126.	140.	44.9	31.0	.975+05	.960+05	0.	.49+06	.48+06	29.2	17.3	1.5	.23	.14	.16+00	.13-04
MMH	161	SEP	125.	143.	45.1	45.4	.106+06	.134+06	0.	.53+06	.67+06	35.5	55.3	3.7	.28	.44	.35+00	.13-04
MMH	162	SEP	148.	175.	96.5	78.6	.187+06	.164+06	0.	.93+06	.82+06	80.9	58.8	1.9	.55	.40	.47+00	.10-04
MMH	163	SEP	125.	131.	26.5	30.1	.353+05	.949+05	0.	.18+06	.47+06	1.6	17.3	21.8	.01	.14	.43-01	.15-04
MMH	164	SEP	125.	131.	26.7	29.5	.350+05	.943+05	0.	.17+06	.47+06	1.5	17.7	23.8	.01	.14	.42-01	.15-04
MMH	165	SEP	125.	131.	26.5	29.8	.340+05	.952+05	0.	.17+06	.48+06	1.4	18.1	26.6	.01	.15	.40-01	.15-04
MMH	166	M/S	81.	89.	7.4	9.5	.220+05	.675+05	0.	.11+06	.34+06	1.5	20.0	27.6	.02	.25	.67-01	.23-04
MMH	167	M/S	79.	87.	7.1	8.8	.222+05	.662+05	0.	.11+06	.33+06	1.4	20.5	29.9	.02	.26	.68-01	.23-04
MMH	168	UNDEF	127.	67.	7.7	5.6	.166+05	.394+05	0.	.17+05	.39+05	1.4	20.5	30.5	.01	.16	.42-01	.21-04
MMH	169	UNDEF	127.	62.	6.1	5.3	.149-05	.381+05	0.	.15+05	.38+05	1.4	20.5	29.9	.01	.16	.42-01	.24-04
MMH	170	M/S	127.	62.	6.1	5.3	.149+05	.381+05	0.	.15+05	.38+05	1.4	20.5	29.9	.01	.16	.42-01	.24-04
MMH	171	UNDEF	126.	61.	5.9	5.3	.152+05	.384+05	0.	.15+05	.38+05	1.6	21.1	26.2	.01	.17	.47-01	.24-04
MMH	172	UNDEF	126.	62.	6.1	5.4	.156+05	.389+05	0.	.16+05	.39+05	1.8	21.6	25.2	.01	.17	.49-01	.24-04
MMH	173	M/S	126.	62.	6.1	5.4	.158+05	.392+05	0.	.16+05	.39+05	1.8	21.6	24.4	.01	.17	.50-01	.24-04
MMH	174	M/S	125.	63.	6.2	5.5	.162+05	.394+05	0.	.16+05	.39+05	1.9	21.6	23.1	.02	.17	.51-01	.24-04
MMH	222	SEP	124.	46.	5.9	5.9	.188+05	.555+05	0.	.17+06	.50+06	1.0	17.3	35.6	.01	.14	.33-01	.67-04
MMH	223	SEP	101.	38.	3.2	3.4	.155+05	.467+05	0.	.14+06	.42+06	1.0	17.7	35.4	.01	.18	.32-01	.82-04
MMH	224	M/S	81.	31.	1.7	1.8	.128+05	.386+05	0.	.11+06	.35+06	1.0	18.1	35.2	.01	.22	.53-01	.10-03
MMH	225	SEP	149.	56.	10.4	10.9	.231+05	.694+05	0.	.21+06	.62+06	1.0	18.1	35.2	.01	.12	.29-01	.56-04
MMH	226	SEP	123.	48.	8.4	6.5	.459+05	.598+05	0.	.41+06	.54+06	15.0	20.5	3.3	.12	.17	.14+00	.62-04
MMH	227	SEP	125.	49.	10.0	6.3	.625+05	.585+05	0.	.56+06	.53+06	32.1	19.0	1.5	.26	.15	.20+00	.60-04
MMH	228	SEP	124.	50.	10.3	8.9	.663+05	.789+05	0.	.60+06	.71+06	37.0	54.1	3.5	.30	.44	.36+00	.60-04

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HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR DMS-75

FUEL TYPE	TEST NO.	INJECTOR TYPE	DO (IN)	DF (IN)	L/D	IMP ANGLE (DEG)	PC (PSIA)	VO (FT/S)	VF (FT/S)	TO (F)	TF (F)	MR	MF/MO	MODE	REACT (SEC)
MMH	229	VDT-A CORE	.047	.042	9.	0.	150.	54.5	71.5	127.	275.	1.73	.951	SEP	.385-03
MMH	230	VDT-A CORE	.047	.042	9.	0.	124.	43.8	55.4	89.	185.	1.73	.917	SEP	.753-04
MMH	231	VDT-A CORE	.047	.042	9.	0.	124.	43.7	52.6	78.	95.	1.73	.871	SEP	.185-04
MMH	232	VDT-A BARRIER	.042	.042	10.	0.	126.	45.0	51.7	79.	[illegible]	1.44	.799	SEP	.154-04
MMH	233	VDT-A BARRIER	.042	.042	10.	0.	103.	37.3	42.1	79.	83.	1.47	.769	M/S	.124-04
MMH	234	VDT-A BARRIER	.042	.042	10.	0.	80.	29.7	34.0	78.	81.	1.46	.789	MIX	.961-05
MMH	235	VDT-A BARRIER	.042	.042	10.	0.	152.	54.8	60.6	75.	80.	1.50	.738	SEP	.163-04
MMH	236	VDT-A BARRIER	.042	.042	10.	0.	127.	45.3	50.6	75.	79.	1.48	.754	SEP	.134-04
MMH	238	T-LOL CON HI DP	.027	.025	8.	1.	122.	100.0	117.9	77.	77.	1.70	.773	SEP	.105-04
MMH	239	T-LOL CON HI DP	.027	.025	8.	1.	102.	84.8	92.9	77.	77.	1.75	.728	M/S	.865-05
MMH	240	T-LOL CON HI DP	.027	.025	8.	1.	80.	67.7	77.2	77.	77.	1.69	.790	MIX	.719-05
MMH	241	T-LOL CON HI DP	.027	.025	8.	1.	151.	125.0	139.4	77.	77.	1.73	.754	SEP	.130-04
MMH	242	T-LOL CON HI DP	.027	.025	8.	1.	125.	102.8	114.5	77.	77.	1.72	.753	SEP	.107-04
MMH	243	T-LOL CON HI DP	.027	.025	8.	1.	124.	104.1	122.3	88.	177.	1.72	.796	SEP	.531-04
MMH	244	T-LOL CON HI DP	.027	.025	8.	1.	125.	103.6	126.2	88.	214.	1.71	.829	SEP	.847-04
MMH	245	T-LOL CON HI DP	.027	.025	8.	1.	125.	103.6	125.3	89.	223.	1.73	.816	SEP	.931-04
MMH	246	T-LOL CON HI DP	.027	.025	8.	1.	125.	107.7	126.1	117.	225.	1.74	.783	SEP	.132-03
MMH	247	T-LOL CON HI DP	.027	.025	8.	1.	151.	130.6	160.8	124.	279.	1.73	.851	SEP	.308-03
MMH	254	T- LOL-H CORE	.030	.028	7.	1.	124.	104.0	118.6	85.	85.	1.66	.790	SEP	.172-04
MMH	255	T- LOL-H CORE	.030	.028	7.	1.	125.	107.9	116.9	85.	86.	1.74	.713	SEP	.172-04
MMH	256	T- LOL-H CORE	.030	.028	7.	1.	101.	86.6	95.2	85.	86.	1.72	.735	SEP	.140-04
MMH	257	T- LOL-H CORE	.030	.028	7.	1.	82.	68.4	75.3	84.	86.	1.72	.735	SEP	.109-04
MMH	258	T- LOL-H CORE	.030	.028	7.	1.	151.	129.1	141.5	84.	85.	1.72	.729	SEP	.203-04
MMH	259	T- LOL-H CORE	.030	.028	7.	1.	124.	107.9	124.2	87.	173.	1.73	.765	SEP	.636-04
MMH	260	T- LOL-H CORE	.030	.028	7.	1.	151.	129.1	141.4	84.	94.	1.74	.724	SEP	.234-04
MMH	261	T- LOL-H CORE	.030	.028	7.	1.	172.	109.3	132.6	87.	240.	1.72	.808	SEP	.140-03
MMH	262	T- LOL-H CORE	.030	.028	7.	1.	123.	109.1	129.9	88.	229.	1.74	.786	SEP	.127-03
MMH	263	T- LOL-H CORE	.030	.028	7.	1.	123.	111.1	131.2	87.	228.	1.75	.773	SEP	.125-03
MMH	264	T- LOL-H CORE	.030	.028	7.	1.	123.	113.2	131.1	124.	231.	1.73	.767	SEP	.196-03
MMH	265	T- LOL-H CORE	.030	.028	7.	1.	152.	134.9	162.6	127.	280.	1.73	.798	UNDEF	.406-03
MMH	266	T- LOL-H CORE	.030	.028	7.	1.	152.	133.4	162.0	125.	276.	1.72	.811	UNDEF	.383-03
MMH	273	VDT-A CORE	.047	.042	9.	0.	122.	44.0	52.9	89.	90.	1.71	.876	SEP	.193-04
MMH	274	VDT-A CORE	.047	.042	9.	0.	127.	45.3	53.8	89.	90.	1.74	.857	SEP	.196-04
MMH	276	VDT-A CORE	.047	.042	9.	0.	80.	30.0	34.7	90.	90.	1.78	.815	M/S	.128-04
MMH	277	VDT-A CORE	.047	.042	9.	0.	80.	29.8	35.1	89.	89.	1.74	.844	M/S	.126-04
MMH	278	VDT-A CORE	.047	.042	9.	0.	80.	29.3	35.5	89.	90.	1.70	.891	M/S	.129-04
MMH	279	VDT-A CORE	.047	.042	9.	0.	80.	29.3	35.3	88.	89.	1.71	.882	M/S	.126-04
MMH	280	VDT-A CORE	.047	.042	9.	0.	128.	45.4	52.6	88.	89.	1.78	.817	SEP	.187-04
MMH	281	VDT-A CORE	.047	.042	9.	0.	128.	45.4	53.0	88.	89.	1.76	.829	SEP	.189-04

HIGH PERFORMANCE N2O4 / AMINE ELEMENTS

HYPERGOLIC STREAM IMPINGMENT DATA COMPILATION

INVESTIGATOR OMS-75

FUEL TYPE	TEST NO.	MODE	PC (PSIA)	VAVG	WEF	WEO	REF	REO	DELTI (DEG F)	RELF	RELO	PPF (PSIA)	PPO (PSIA)	MRVP	XF	XO	XP	RESID
MMH	229	SEP	150.	61.	20.0	15.7	.987+05	.954+05	0.	.89+06	.86+06	62.1	56.5	2.3	.41	.38	.39+00	.49-04
MMH	230	SEP	124.	48.	8.1	6.7	.441+05	.621+05	0.	.40+06	.56+06	14.0	23.7	4.0	.11	.19	.15+00	.63-04
MMH	231	SEP	124.	47.	6.2	6.3	.224+05	.579+05	0.	.20+06	.52+06	1.7	18.1	22.1	.01	.15	.45-01	.67-04
MMH	232	SEP	126.	48.	6.0	6.1	.201+05	.536+05	0.	.20+06	.54+06	1.2	18.6	30.2	.01	.15	.38-01	.66-04
MMH	233	M/S	103.	39.	3.2	3.4	.162+05	.444+05	0.	.16+06	.44+06	1.2	18.6	30.9	.01	.16	.46-01	.83-04
MMH	234	MIX	60.	31.	1.6	1.7	.129+05	.352+05	0.	.13+06	.35+06	1.1	18.1	31.7	.01	.23	.57-01	.10-03
MMH	235	SEP	152.	57.	9.9	10.7	.228+05	.637+05	0.	.23+06	.64+06	1.1	16.9	30.4	.01	.11	.29-01	.58-04
MMH	236	SEP	127.	47.	5.7	6.1	.169+05	.527+05	0.	.19+06	.53+06	1.1	16.9	31.2	.01	.13	.34-01	.69-04
MMH	238	SEP	122.	105.	16.3	18.5	.246+05	.756+05	0.	.20+06	.60+06	1.0	17.7	34.4	.01	.15	.35-01	.16-04
MMH	239	M/S	102.	85.	9.2	11.1	.203+05	.642+05	0.	.16+06	.51+06	1.0	17.7	34.4	.01	.17	.42-01	.22-04
MMH	240	MIX	80.	71.	5.0	5.6	.168+05	.512+05	0.	.13+06	.41+06	1.0	17.7	34.4	.01	.22	.53-01	.27-04
MMH	241	SEP	151.	130.	30.7	35.8	.304+05	.945+05	0.	.24+06	.76+06	1.0	17.7	34.4	.01	.12	.28-01	.15-04
MMH	242	SEP	125.	107.	17.2	20.0	.250+05	.777+05	0.	.20+06	.62+06	1.0	17.7	34.4	.01	.14	.34-01	.18-04
MMH	243	SEP	124.	111.	23.2	21.6	.551+05	.842+05	0.	.44+06	.67+06	12.0	23.2	4.5	.10	.19	.13+00	.17-04
MMH	244	SEP	125.	112.	25.8	21.6	.716+05	.840+05	0.	.57+06	.67+06	24.6	23.2	2.3	.20	.19	.19+00	.17-04
MMH	245	SEP	125.	112.	27.0	21.7	.752+05	.844+05	0.	.60+06	.67+06	28.4	23.7	2.1	.23	.19	.21+00	.17-04
MMH	246	SEP	125.	114.	27.5	27.5	.766+05	.103+06	0.	.61+06	.82+06	29.2	45.4	3.7	.23	.36	.29+00	.17-04
MMH	247	SEP	151.	142.	61.0	51.1	.135+06	.129+06	0.	.11+07	.10+07	65.1	52.9	2.1	.43	.35	.39+00	.15-04
MMH	254	SEP	124.	109.	20.7	23.6	.310+05	.918+05	0.	.22+06	.64+06	1.3	21.6	34.0	.01	.17	.42-01	.20-04
MMH	255	SEP	125.	111.	20.3	25.6	.308+05	.952+05	0.	.22+06	.67+06	1.3	21.6	33.3	.01	.17	.42-01	.20-04
MMH	256	SEP	101.	90.	10.9	13.3	.251+05	.764+05	0.	.18+06	.53+06	1.3	21.6	33.3	.01	.21	.52-01	.24-04
MMH	257	SEP	82.	71.	5.5	6.7	.199+05	.600+05	0.	.14+06	.42+06	1.3	21.1	32.5	.02	.26	.64-01	.31-04
MMH	258	SEP	151.	134.	35.9	44.0	.370+05	.113+06	0.	.26+06	.79+06	1.3	21.1	33.2	.01	.14	.34-01	.16-04
MMH	259	SEP	124.	114.	26.6	25.6	.610+05	.964+05	0.	.43+06	.67+06	11.0	22.6	4.6	.09	.18	.13+00	.19-04
MMH	260	SEP	151.	134.	36.4	44.0	.398+05	.113+06	0.	.28+06	.79+06	1.6	21.1	26.2	.01	.14	.39-01	.17-04
MMH	261	SEP	122.	[illegible]	34.3	25.8	.967+05	.975+05	0.	.69+06	.68+06	35.5	22.6	1.6	.29	.19	.25+00	.18-04
MMH	262	SEP	127.	117.	32.4	26.1	.905+05	.981+05	0.	.63+06	.69+06	30.9	23.2	1.9	.25	.19	.22+00	.16-04
MMH	263	SEP	123.	118.	33.0	26.9	.909+05	.992+05	0.	.64+06	.69+06	30.5	22.6	1.9	.25	.16	.21+00	.16-04
MMH	264	SEP	123.	120.	33.1	34.7	.925+05	[illegible]	0.	.65+06	.87+06	31.7	52.9	3.9	.26	.43	.33+00	.16-04
MMH	265	SEP	152.	145.	73.5	62.2	.154+06	.151+06	0.	.11+07	.11+07	65.9	56.5	2.2	.43	.37	.40+00	.14-04
MMH	266	SEP	152.	144.	69.4	60.0	.150+06	.148+06	0.	.11+07	.10+07	62.9	54.1	2.2	.41	.36	.38+00	.14-04
MMH	273	SEP	122.	47.	6.1	6.6	.216+05	.624+05	0.	.19+06	.56+06	1.4	23.7	33.4	.01	.19	.48-01	.66-04
MMH	274	SEP	127.	48.	5.6	7.3	.220+05	.643+05	0.	.20+06	.58+06	1.4	23.7	33.4	.01	.19	.46-01	.65-04
MMH	276	M/S	80.	32.	1.7	2.0	.142+05	.428+05	0.	.13+06	.39+06	1.4	24.2	34.1	.02	.30	.73-01	.10-03
MMH	277	M/S	80.	32.	1.8	2.0	.142+05	.422+05	0.	.13+06	.38+06	1.4	23.7	34.1	.02	.30	.72-01	.10-03
MMH	278	M/S	80.	32.	1.8	1.9	.145+05	.416+05	0.	.13+06	.37+06	1.4	23.7	33.4	.02	.30	.72-01	.99-04
MMH	279	M/S	80.	32.	1.8	1.9	.143+05	.413+05	0.	.13+06	.37+06	1.4	23.2	33.4	.02	.29	.71-01	.94-04
MMH	280	SEP	128.	48.	6.6	7.4	.214+05	.639+05	0.	.19+06	.58+06	1.4	23.2	33.4	.01	.18	.44-01	.67-04
MMH	281	SEP	128.	48.	6.5	7.4	.215+05	.639+05	0.	.19+06	.58+06	1.4	23.2	33.4	.01	.18	.44-01	.66-04

ZETA PL . FILE HAS BEEN CREATED ... 4512 CHARACTERS

LIST OF APPENDIX E

DATA SOURCES

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   Lawver, B. R., "High Performance N_2O_4/Amine Elements "Blowapart" Report 14186-DRL-3-1, Contract NAS 9-14186 November 1974

2. Investigator - RCKTD
   Hines, W. S., "High Performance N_2O_4/Amine Elements Task III Definition of Governing Mechanisms Data Dump", Report 75 RC1635, Contract NAS9-14126, Rocketdyne, March 1975

3. Investigator - Zung - From Reference 27
   Zung, L. B., and White, S. R., "Combustion Process of Impinging Hypergolic Propellants", NASA CR 1704 Mardhall Industries, Irvine California, May 1971

4. Investigator - OMS-75

   Ito, J. I., "Development of Test Report OMS Injector Subscale Pattern Evaluation", Report No. 6673:207 PDRD TM05-25, Contract M4JXMA-483030H, ALRC, March 1976

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